COMMONWEALTH of VIRGINIA

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January 11, 2010

Mr. Greg C. Voigt
USEPA REGION 3
1650 Arch Street
Philadelphia, PA 19103-2029

Dear Mr. Voigt:

As part of the May 1, 2010 TMDL submittal requirements, Virginia proposes to re-categorize VAP-H39R_JMS03A98 this segment from category 5 to category 4A. This was reported as impaired on Virginia's 1998 303(d) list.

VADEQ is requesting EPA to approve the re-categorization of this impairment currently on Virginia's 303(d) List. VDEQ anticipates the benthic impairments observed in this river segment will be resolved through the imminent Development for the James River and Tributaries – City of Richmond Bacteria TMDL, Implementation Plan, and Implementation. The impairment would be officially re-categorized in the 303(d) List as part of the 2010 305(b)/303(d) Integrated Report submittal. VADEQ is requesting your approval of this re-categorization action now, because such an approval will allow us to clearly communicate the new status of these waters to the public during the ongoing TMDL studies in the affected watersheds. A brief summary of the Consent Decree impairment and the supporting data and information for the re-categorization request is provided in Attachments 1-3.

Please contact Mr. Charles Martin at (804) 698-4462 if you or your staff have questions on this submittal,.

Sincerely,

Charles H. Martin
Environmental Program Manager
Watershed Programs

Attachments (3)

cc: Alan Pollock, VADEQ
Darryl Glover, VADEQ
Jack Frye, VADCR
File

ATTACHMENT 1
Re-categorization Summary for James River Benthic Impairment

The following documentation supports VDEQ's request to re-categorize portions of the James River (cause group code: H39R-09-BEN) benthic impairment (Table 1). Results of the stressor analysis indicated that a most probable stressor could not be determined from available data. However, the impaired benthic monitoring station (2-JMS110.34) is located approximately 1,771 ft. downstream of a combined sewer overflow (CSO) discharge point. The James River Wastewater Treatment Plant (WWTP) (VA0063177) CSO discharge may be related to the impact of the benthic community in ways that the current data do not indicate. Additional information on the background and history of the impairment listing and rationale for the re-categorization request are provided below and in the attached preliminary stressor analysis (by Map Tech, Inc). VDEQ is currently completing a bacteria TMDL on the James River (consent decree) which includes the area of this benthic impairment (James River (lower) VAP-H39R-08). VDEQ anticipates the benthic impairments observed in this river segment will be resolved through the imminent James River Bacteria TMDL, Implementation Plan, and Implementation.

Table 1. Consent Decree Segment for James River Benthic Impairment in 1996

Segment ID	Stream Name	Impairment	Size (mi^2)	CD Status	CD Category Change Requested
VAP-H39R_JMS03A98	James River	Biological	2.99	Category 5	Category 4A

Table 2. Summary of Virginia Stream Condition Index (VSCI) scores for James River by Year

	2006	2007	2008	2009
VSCI	58.7	61.6	58.8	60.2
n	4	4	4	2

n = number of VSCI scores represented by Spring and Fall monitoring

During a conference call on December 3, 2009 with EPA Region III, EPA staff indicated they would entertain a re-categorization request of the James River benthic impairment to Category 4(a) given the lack of obvious stressor for the benthic impairment and presence of upstream combined sewer outfalls which will be addressed in the soon to be completed James River Bacteria TMDL – City of Richmond.

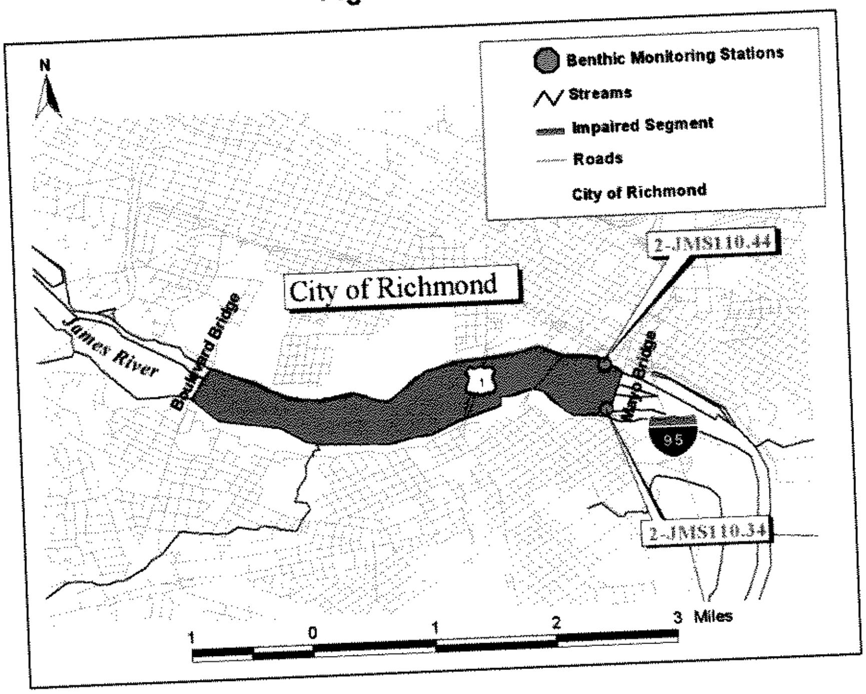
Background and History

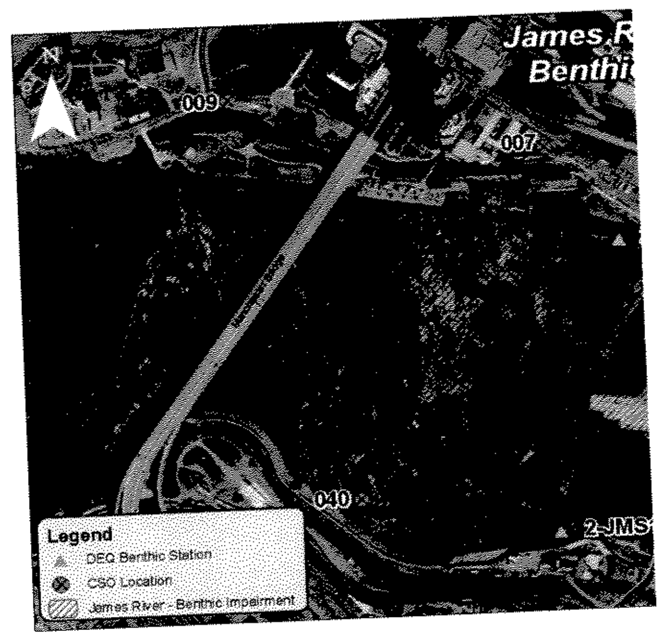
The James River was assessed as not supporting of the Aquatic Life use in 1996 based on the biological (benthic) monitoring at stations 2-JMS110.34 and 2-JMS110.44. These data indicated moderately impaired benthic communities when compared to the control station at 2-

JMS115.29 (Figure 1).

Habitat scores throughout the reach were good with low embeddedness and relatively clean substrate. Ambient water quality results for the river (at, above and below these two stations) indicated no conditions/parameters that would explain a benthic impairment. It is determined that metals or toxics were not the cause of a benthic impairment in the lower falls of James River. While PCBs and metals were detected at two sediment sites and one in-stream sediment sampling station, levels were below probable effect levels. Two of these stations were also sampled for pesticides; all of which were also below probable effect levels.

Figure 1. ***Benthic monitoring stations on the James River***





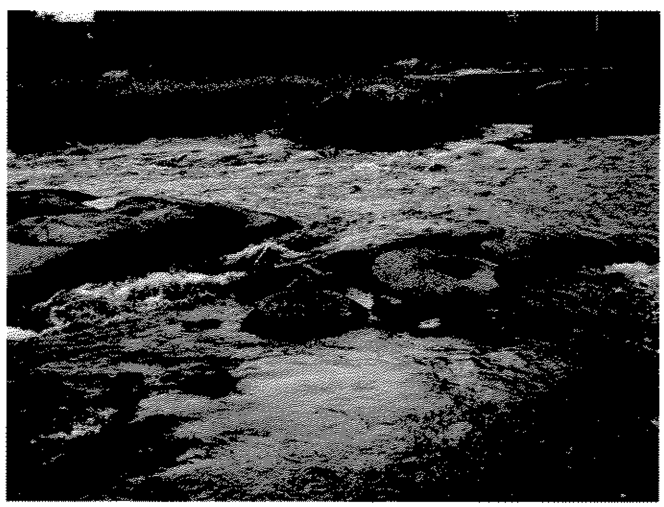
Recategorization Rationale

Habitat and Seasonal Flow

The "fall line" of the James River is very dynamic and diverse as it flows through Richmond (Figures 2 & 3). There are numerous islands and side channels, substrate sizes, and flow regimes on this section of river. Benthic monitoring station, 2-JMS110.34, is located along the south channel where the accessible substrate is often dominated by boulders and bedrock. The river is swift through this section and there are many deep runs. However, during low flows, which often occur in Fall months, this area is more accessible and more favorable habitat for benthic macroinvertebrate collection can be sampled. Since sampling resumed in 2005, the two highest VSCI scores were observed during the lowest Fall flows (VSCI 65.3 at 866 cfs and VSCI 60.3 at 1010 cfs). The lowest VSCI score was observed during the highest Spring flow (VSCI 38.7 at 5340 cfs). VADEQ plans to investigate new sites on the south channel that are more accessible during Spring high flows with cobble as the dominate substrate.

Figure 2. South channel of James River looking upstream from fall line above Mayos Bridge

Figure 3. North channel of James River River looking upstream from fall line above Mayos Bridge



Seasonal Differences (un-related to flow)

There may be a natural seasonal difference in this part of the James River. Since 2005, VSCI scores have been significantly lower in the Spring as compared to the Fall for each year (Table 3). This difference was observed at both stations (north and south channels) across the river. The north channel is shallower with less flow, and characterized by more cobble substrate than the south channel site. Samples from the north channel during both seasons have scored above 60 on the VSCI (with the exception of a single high flow event in the Spring of 2005).

Improving Trend

The south channel station has shown some improvement in the VSCI scores since 1994 which are observed during Fall sampling. The south channel scores reached the "fully supporting for aquatic life use" category in the Fall of 2007 (VSCI 65.3) and Fall 2008 score of 60.3 (Table 3). The south channel sampling station is approximately 1,771 feet below the James River WWTP CSO #040. The CSO #040 is unique in that it is a diffuser apparatus that extends via pipe approximately 100 feet into the river (from south bank). While there are CSO outfalls upstream of the north channel sample station, they are not dispersed via diffuser mid-river (see Figure 4).

Table 3. Virginia Stream Condition Index (VSCI) scores for James River (H39R-08-BEN) by season (2006-2009)

Station	Channel	Season	VSCI Score
2-JMS110.44	North	Spring 2006	61.6
		Fall 2006	65.1
		Spring 2007	60.3
		Fall 2007	67.4
		Spring 2008	65.8
		Fall 2008	64.6
		Spring 2009	65.5
2-JMS110.34	South	Spring 2006	49.3
		Fall 2006	58.9
		Spring 2007	53.5
		Fall 2007	65.3
		Spring 2008	44.3
		Fall 2008	60.3
		Spring 2009	54.9

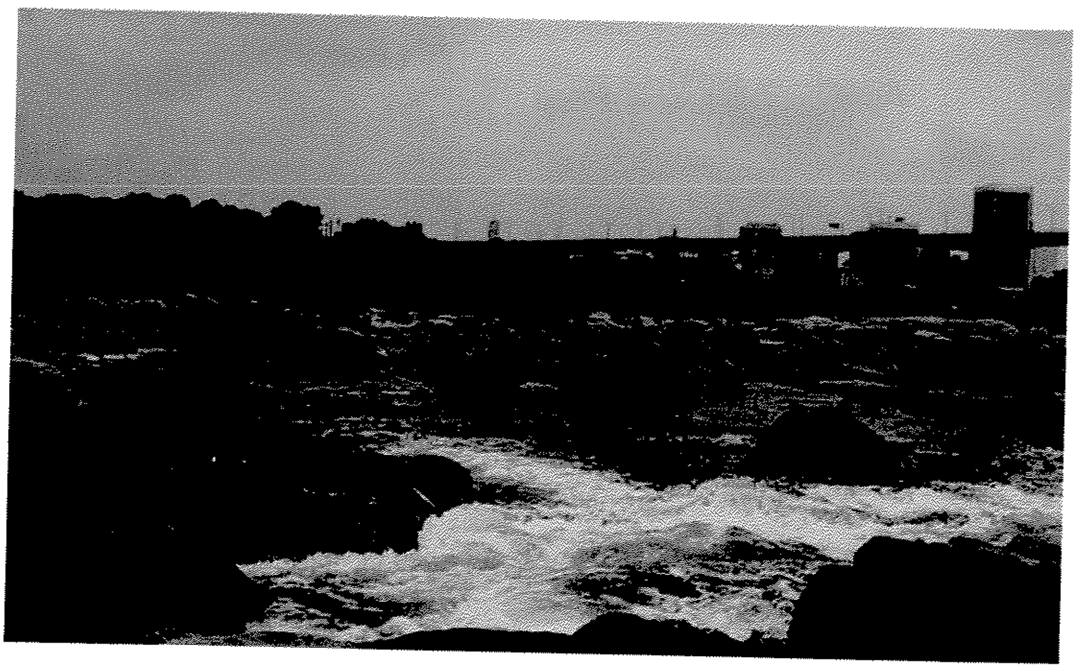
Figure 4. Location of City of Richmond CSOs in the vicinity of James River benthic monitoring stations.

Conclusion

Per direction from the United States Environmental Protection Agency (USEPA) the bacteria TMDL, scheduled for completion by May 1, 2010, will address storm water loading reductions. In addition MapTech, Inc. has been contracted to develop a TMDL implementation plan for the City of Richmond area that specifically addresses stormwater and related combined sewer overflow (CSO) best management practices (BMPs).

Given the only potential stressor to the benthic community will be addressed by an imminent bacteria TMDL and implementation plan, the VADEQ recommends the benthic impairment (stations 2-JMS110.34 and 2-JMS110.44) of the James River be re-categorized from Category 5 to Category 4(a) on the 2010 305(b)/303(d) Water Quality Assessment Integrated Report. Additionally, VADEQ will continue to monitor at benthic and ambient monitoring station 2-JMS110.34.

General Standard Benthic Stressor Identification For the James River at Richmond, Virginia



Prepared for: Virginia's Department of Environmental Quality
Date Submitted: December 8, 2009
Contract #: 14466
Prepared by MapTech for New River Highlands.
Submitted to VADEQ by New River Highlands.

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ACKNOWLEDGEMENTS

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CONTENTS

FIGURES

TABLES

EXECUTIVE SUMMARY

Background and Applicable Standards

The study area for this project is the main stem of the James River located within the City of Richmond. James River (VAP-H39R_JMS03A98) was initially listed in 1996 for violations of the aquatic life water quality standard due to low benthic macroinvertebrate scores. MapTech, Inc is developing a Total Maximum Daily Load (TMDL) for this segment for fecal coliform.

The General Standard is implemented by the Virginia Department of Environmental Quality (VADEQ) through application of the Virginia Stream Condition Index (VASCI). The health of the benthic macroinvertebrate community is assessed through measurement of eight biometrics statistically derived from numerous reference sites in the non-coastal regions of Virginia. Surveys of the benthic macroinvertebrate community were assessed at the family taxonomic level. VADEQ's not-impaired benchmark with the VASCI is a total score of 60 (10^{th} percentile of the reference sites).

TMDL Endpoint and Water Quality Assessment

TMDLs must be developed for a specific pollutant(s). Benthic assessments are very good at determining if a particular stream segment is impaired or not, but generally do not provide enough information to determine the cause(s) of the impairment. The process outlined in the Stressor Identification Guidance Document (EPA, 2000) was used to systematically identify the most probable stressors in the James River at Richmond. The stressor analysis was performed by first comparing the data collected at the long term VADEQ monitoring station 2-JMS110.30 just downstream from the impaired benthic monitoring station (2-JMS110.34) with the appropriate water quality standards and screening values. In addition, a comparison was made with a long term VADEQ monitoring station 2-JMS117.35 located upstream from a non-impaired benthic monitoring station. The potential stressors are: sediment, toxics, low dissolved oxygen, nutrients, pH, metals, temperature and organic matter.

The results of the stressor analysis for the James River at Richmond were divided into three categories:

> **Non-Stressor**: Those stressors with data indicating normal conditions, without water quality standard violations or without the observable impacts usually associated with a specific stressor, were eliminated as possible stressors.
>
> **Possible Stressor**: Those stressors with data indicating possible links, but inconclusive data, were considered to be possible stressors.
>
> **Most Probable Stressor**: The stressor(s) with the most consistent information linking it with the poorer benthic and habitat metrics was considered to be the most probable stressor(s).

The results of the stressor analysis indicated that a most probable stressor could not be determined from the available data. However, the impaired benthic monitoring station is located approximately 1,771 feet from a combined sewer overflow discharge point from the City of Richmond and this discharge could be potentially impacting the benthic community in ways that the current data do not indicate.

Per direction from the United States Environmental Protection Agency (USEPA) the fecal coliform TMDL, scheduled to be completed in early 2010, will address storm water loading reductions. In addition MapTech, Inc. has been contracted to develop a TMDL implementation plan for the City of Richmond area that specifically addresses stormwater and related combined sewer overflow (CSO) best management practices (BMPs).

Because the only potential stressor to the benthic community is being addressed by an existing TMDL and implementation plan the impaired benthic segment on the James River that includes monitoring station 2-JMS110.34 will be listed as a category 4(a) water (segment is impaired but a TMDL has been developed) on the 2010 305(b)/303(d) Water Quality Assessment Integrated Report. VADEQ will continue to monitor at benthic and ambient monitoring station 2-JMS110.34.

1. INTRODUCTION

1.1 Background

The Clean Water Act (CWA) that became law in 1972 requires that all U.S. streams, rivers, and lakes meet certain water quality standards. The CWA also requires that states conduct monitoring to identify waters that are polluted or do not otherwise meet standards. Through this required program, the state of Virginia has found that many stream segments do not meet state water quality standards for protection of the six beneficial uses: recreation/swimming, aquatic life, wildlife, fish consumption, shellfish consumption, and public water supply (drinking).

When streams fail to meet standards, Section 303(d) of the CWA and the U.S. Environmental Protection Agency's (EPA) Water Quality Management and Planning Regulation (40 CFR Part 130) both require that states develop a Total Maximum Daily Load (TMDL) for each pollutant. A TMDL is a "pollution budget" for a stream; that is, it sets limits on the amount of pollution that a stream can tolerate and still maintain water quality standards. In order to develop a TMDL, background concentrations, point source loadings, and nonpoint source loadings are considered. A TMDL accounts for seasonal variations and must include a margin of safety (MOS).

Once a TMDL is developed and approved by EPA, measures must be taken to reduce pollution levels in the stream. Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) states in section 62.1-44.19:7 that the *"Board shall develop and implement a plan to achieve fully supporting status for impaired waters"*. The TMDL Implementation Plan (IP) describes control measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), which should be implemented in a staged process. Through the TMDL process, states establish water-quality based controls to reduce pollution and meet water quality standards.

The study area for this project is the main stem of the James River located within the City of Richmond. For the purposes of this report, this watershed shall be referred to as the James River area. See Figure 1.1.

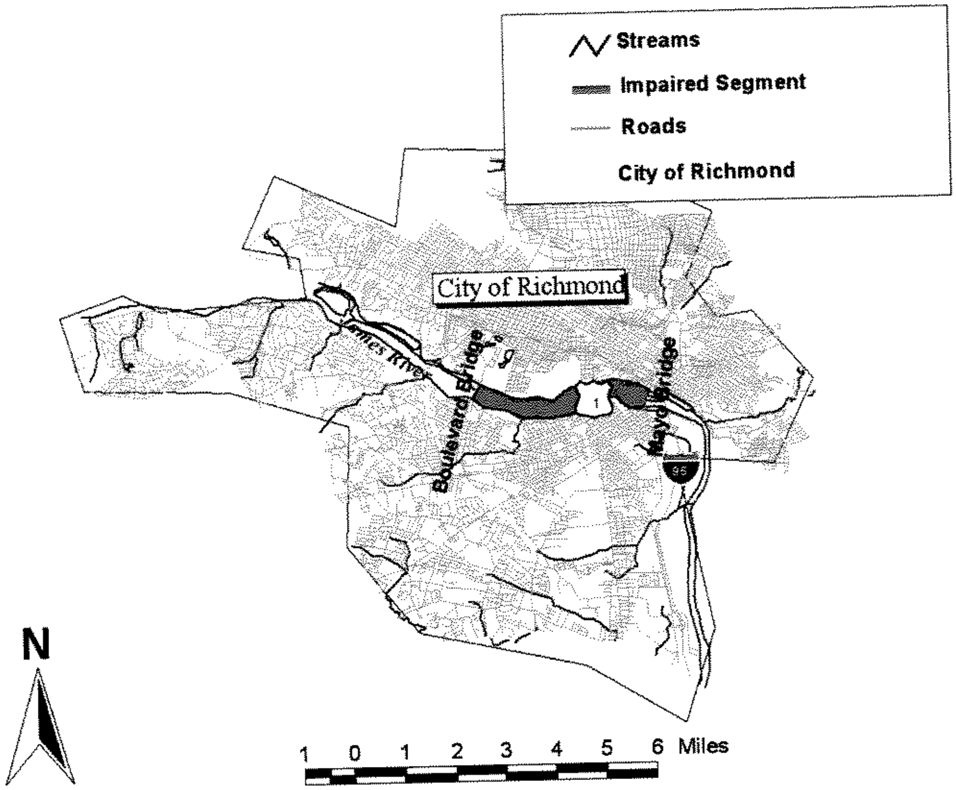

Figure 1.1 Impaired stream segment in the James River – City of Richmond benthic impairment.

Table 1.1 lists, for each impairment, the VADEQ water quality monitoring station used for impaired waters assessment, the initial year that the segment was listed in the Section 303(d) list, current miles affected in the 2008 listing, and the location of listing. Figure 1.2 shows the current impaired segment.

James River (VAP-H39R_JMS03A98) was initially listed in 1996 for violations of the aquatic life water quality standard due to low benthic macroinvertebrate scores.

Table 1.1 Aquatic life impairment on the 2008 Section 305(b)/303(d) *Water Quality Integrated Report* within the James River.

Stream Name HUP	Listing Station ID	Initial Listing Year	River Length Affected (miles)	Location
James River VAP-H39R_JMS03A98	2-JMS110.34	1996	2.99	Boulevard Bridge to the fall line near the Mayo Bridge

1.2 James River Study Area Watershed Characteristics

The James River study area watershed is entirely located within the level III Southeastern Plains ecoregion (65). The level IV subset is the Rolling Coastal Plain ecoregion. The level IV ecoregion is "a rolling, hilly, dissected portion of the Inner Coastal Plain that is made up of sedimentary material. Lithology is distinct from the adjacent Northern Outer Piedmont (45f) that is composed of metamorphic rocks. The terrain is hillier than the Chesapeake-Albemarle Silty Lowlands and Tidal Marshes (63b). Elevations typically range from 30 to 250 feet and local relief is 25 to 175 feet (7.6-53 m). Relief, elevation, and channel gradients are generally greater than in the Middle Atlantic Coastal Plain (63); correspondingly, drainage also tends to be better. Stream margins can be swampy and stained water can occur. Parts of the Fall Zone are included in the westernmost portion of the Rolling Coastal Plain (65m); here aquatic habitats vary between the islands, pools, swampy streams, and cascades of the zone.

The Rolling Coastal Plain (65m) is mostly underlain by unconsolidated Tertiary sand, silt, clay, and gravels of the Bacons Castle Formation and the Chesapeake Group (Virginia Division of Mineral Resources, 1993); Holocene-age deposits and metamorphic rocks are typically absent. Ultisols are common and have a thermic temperature regime (Buol, 1974); they are better drained than the Aquults of the Middle Atlantic Coastal Plain (63) and are warmer than the soils of the Chesapeake Rolling Coastal Plain (65n). The soils support a potential natural vegetation of Oak-Hickory-Pine Forest (dominants: hickory, longleaf pine, shortleaf pine, loblolly pine, white oak and post oak) (Kuchler, 1964).

Today, Ecoregion 65m is a mosaic of woodland and farmland (U.S. Soil Conservation Service, various dates). Common crops are corn, soybeans, and, in the south, peanuts (Bureau of the Census, 1995). Hardwoods are now more common than at the time of settlement because of frequent fires and the repeated preferential cutting of pine. The Fall Line acts as the western border and separates Ecoregion 65m from the higher and lithologically distinct Northern Outer Piedmont (45f). Its eastern limit is the Suffolk and

Harpersville scarps which separate it from the low, flat terraces of Ecoregion 63b. Its southeastern boundary is the Surry Scarp that divides it from the middle-elevation terraces of Ecoregion 63e. Ecoregion 65m's northern border with the Chesapeake Rolling Coastal Plain (65n) is the Potomac River where forest density and soil temperature regimes change."

(http://www.eoearth.org/article/Ecoregions_of_Delaware%2C_Maryland%2C_Pennsylvania%2C_Virginia%2C_and_West_Virginia_(EPA).

As for the climatic conditions in the James River study area watershed, during the period from 1948 to 2008 the Richmond WSO Airport, Virginia (NCDC station# 447201) received an average annual precipitation of approximately 44.07 inches, with 56% of the precipitation occurring during the May through October growing season (SERCC, 2009). Average annual snowfall is 6.6 inches, with the highest snowfall occurring during February (SERCC, 2009). The highest average daily temperature of 89.0 °F occurs in July, while the lowest average daily temperature of 30.2 °F occurs in January (SERCC, 2009).

2. BETHNIC WATER QUALITY ASSESSMENT

2.1 Applicable Criterion for Benthic Impairment

The General Standard, as defined in Virginia state law 9 VAC 25-260-20, states:

> A. *All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.*

The General Standard used to be implemented by VADEQ through application of the modified Rapid Bioassessment Protocol II (RBP II) (Barbour, 1999). However, in January 2008, VADEQ moved to a multimetric index approach called the Virginia Stream Condition Index (VASCI) (Burton, 2003). The health of the benthic macroinvertebrate community is assessed through measurement of eight biometrics statistically derived from numerous reference sites in the non-coastal regions of Virginia (Table 2.1). Surveys of the benthic macroinvertebrate community performed by VADEQ are assessed at the family taxonomic level. All eight biometrics in Table 2.1 are measured during all benthic surveys and the total VACSI score is the sum of the eight individual scores. The VADEQ benchmark for a "not impaired" status is a VASCI total score of 60; (if a stream scores less than 60, it is considered impaired).

Table 2.1 Components of the Virginia Stream Condition Index (VASCI).

Biometric	Abbreviation	Benthic Health [1]
Total Taxa Score	Richness Score	↑
EPT Taxa Score	EPT Score	↑
% Ephemeroptera Score	% Ephem. Score	↑
% Plecoptera plus Trichoptera less Hydopschyidae Score	% P+T-H Score	↑
% Scraper Score	% Scraper Score	↑
% Chironomidae Score	% Chironomidae Score	↓
% Two Dominant Families Score	% 2 Dom. Score	↓
Modified Family Biotic Index (MFBI) Score	% MFBI Score	↓

[1] An upward arrow indicates a positive response in benthic health when the associated biometric increases.

2.2 Benthic Assessment – James River

The James River in Richmond, Virginia was initially listed on the *1996 303(d) TMDL Priority List* as not supporting the aquatic life use and has remained on all subsequent 303(d) lists. All VADEQ biological water quality monitoring (benthic survey), ambient water quality monitoring and special study stations on the James River in the vicinity of the impaired segment are shown in Table 2.2 and Figure 2.1.

Table 2.2 VADEQ water quality monitoring stations on the James River in Richmond, VA.

Station	Type	Descriptive Location	River Mile
2-JMS110.00	Fish Tissue/Sediment	Near I-95 Bridge	110.00
2-JMS110.30	Trend	Rt. 360 Bridge	110.30
2-JMS110.31	Special Study	James River,Mayos Br., North Channel	110.31
2-JMS110.34	Watershed/Benthic	South Bank of the James River Below Fall Zone	110.34
2-JMS110.44	Watershed/Benthic	North Bank James River Below Fall Zone	110.44
2-JMS110.49	Special Study	James River at Downstream End of Haxall	110.49
2-JMS110.90	Special Study	James River, Mancherster Br. Near South	110.9
2-JMS111.17	Special Study	James River, at Tredegar Iron Works	111.17
2-JMS111.32	Special Study	James River,Downstream Parkhydro CSO	111.32
2-JMS111.35	Special Study	James River,Upstream Parkhydro CSO, North	111.35
2-JMS111.47	Special Study	James River, North Bank of Belle Isle	111.47
2-JMS111.48	Special Study	James River,Downstream Canoe Run CSO, South	111.48
2-JMS111.55	Special Study	James River, Upstream Ocanoe Rin CSO, South	111.55
2-JMS112.33	Special Study	James River at Texas Avenue Beach	112.33
2-JMS112.37	Special Study	James River at Mouth of Reedy Creek	112.37
2-JMS112.79	Special Study	James River, 676m Above mouth of Reedy Creek	112.79
2-JMS113.20	Watershed	Boulevard Bridge	113.20
2-JMS113.39	Fish Tissue/Sediment	Upstream from Boulevard Bridge	113.39

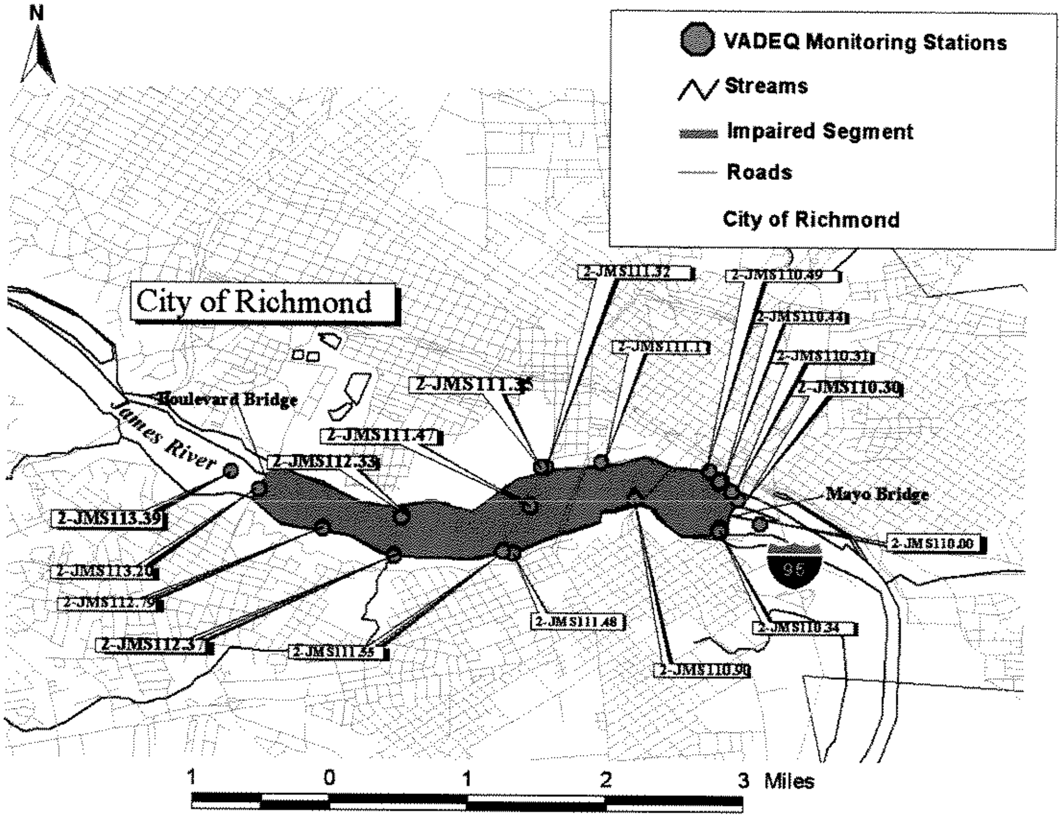

Figure 2.1 VADEQ water quality monitoring stations on the James River at Richmond.

Fourteen benthic surveys were performed by the VADEQ from November 1994 through November 2008 at benthic monitoring station 2-JMS110.34 and 15 were performed at station 2-JMS110.44. The VASCI scores are presented in Table 2.3 and Figure 2.2. The results indicate that the surveys found impaired conditions in 12 surveys at monitoring station 2-JMS110.34, and seven surveys were found to be impaired at monitoring station 2-JMS110.44.

Table 2.3 VASCI biological monitoring scores for station 2-JMS110.34 on the James River in Richmond, VA.

	Date												
	Fall 1994	**Spring 1995**	**Spring 1996**	**Fall 1996**	**Spring 1997**	**Fall 1997**	**Spring 2005**	**Fall 2005**	**Spring 2006**	**Fall 2006**	**Spring 2007**	**Spring 2008**	**Fall 2008**
Metrics													
Richness Score	36.36	45.45	54.55	68.18	59.09	63.64	54.55	63.64	50	54.55	36.36	54.55	59.09
EPT Score	18.18	18.18	27.27	18.18	27.27	36.36	18.18	63.64	45.45	27.27	27.27	36.36	45.45
%Ephem Score	0	28.45	24.76	55.43	37.75	33.2	41.14	27.44	19.52	46.61	70.93	27.67	25.10
%PT-H Score	7.52	0	0	0	0	0	0	21	4.8	8.03	6.11	0.00	7.20
%Scraper Score	39.8	38.31	65.75	28.22	72.07	54.88	32.02	48.9	48.04	100	65.3	22.49	96.07
%Chironomidae Score	100	98.84	88.39	70.87	75.21	77.88	52.17	76.64	75.21	87.62	94.57	75.89	84.62
%2Dom Score	54.19	82.34	95.48	67.34	95.54	100	40.21	75.63	80.28	71.57	40.84	70.96	90.16
%MFBI Score	62.89	66.86	62.63	67.39	59.67	55.18	71.1	71.47	71.39	76.19	86.32	66.18	74.91
VASCI	**39.87**	**47.3**	**52.35**	**46.95**	**53.33**	**52.64**	**38.67**	**56.04**	**49.34**	**58.98**	**53.46**	**44.26**	**60.33**

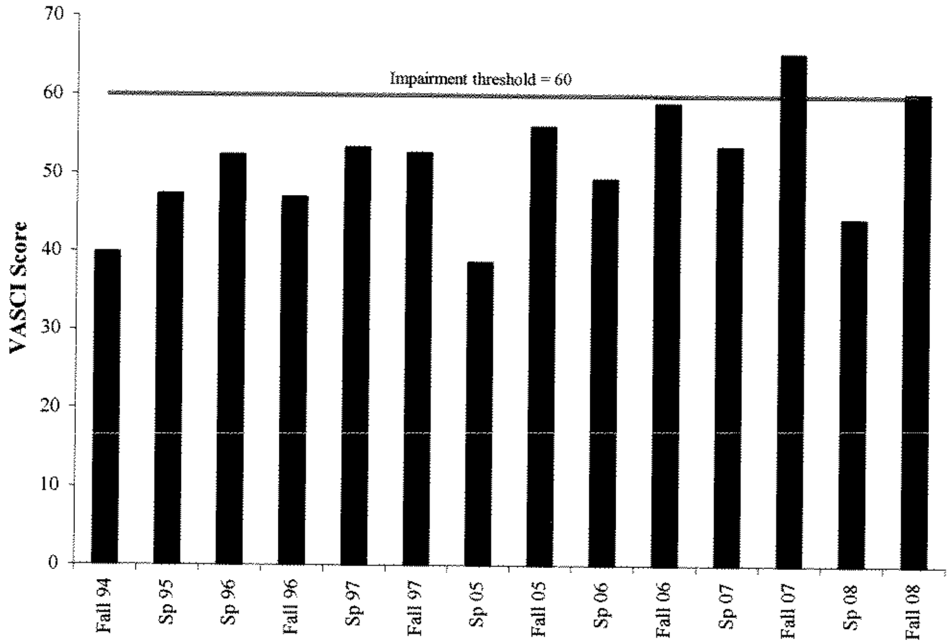

Figure 2.2 VASCI biological monitoring scores for VADEQ benthic monitoring station 2-JMS110.34 on the James River in Richmond, VA.

The VASCI scores for the 15 benthic surveys performed by VADEQ at benthic monitoring station 2-JMS110.44 are presented in Table 2.4 and Figure 2.3. The results indicate that the surveys found seven impaired conditions, and the most recent one was in the spring of 2005.

Table 2.4 VASCI biological monitoring scores for station 2-JMS110.44 on the James River in Richmond, VA.

	Date														
	Fall 1994	Spring 1995	Spring 1996	Fall 1996	Spring 1997	Fall 1997	May 1998	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007	Fall 2007	Spring 2008	Fall 2008
Metrics															
Richness Score	40.91	50	77.27	31.82	95.45	63.64	59.09	59.09	72.73	68.18	63.64	59.09	68.18	72.73	59.09
EPT Score	27.27	18.18	63.64	36.36	45.45	36.36	45.45	54.55	54.55	72.73	63.64	45.45	54.55	90.91	45.45
%Ephem Score	24.12	23.3	42.14	71.97	21.49	39.55	33.79	27.46	8.74	26.74	11.65	100	49.65	50.42	21.96
%PT-H Score	2.44	0	28.09	0	13.46	0	10.03	11.12	17.56	16.12	28.66	9.94	12.21	30.64	40.51
%Scraper Score	92.69	4.61	59.75	47.5	34.81	52.85	63.68	32.62	89.98	54.01	100	32.59	100.00	33.47	80.13
%Chironomidae Score	100	88.1	78.33	88.24	75.45	79.8	82.14	71.29	98.21	93.44	95.92	88.5	99.13	79.09	89.42
%2Dom Score	75.4	77.42	91.52	66.59	100	94.88	82.58	71.54	77.42	85.28	70.78	63.94	70.37	89.33	98.65
%MFBI Score	70.46	52.87	61.03	70.36	54.16	55.41	63.66	69.16	76.94	76.3	86.73	83.16	84.88	80.08	81.17
VASCI	**54.16**	**39.31**	**62.72**	**51.6**	**55.03**	**52.81**	**55.05**	**49.6**	**62.01**	**61.6**	**65.13**	**60.33**	**67.37**	**65.84**	**64.55**

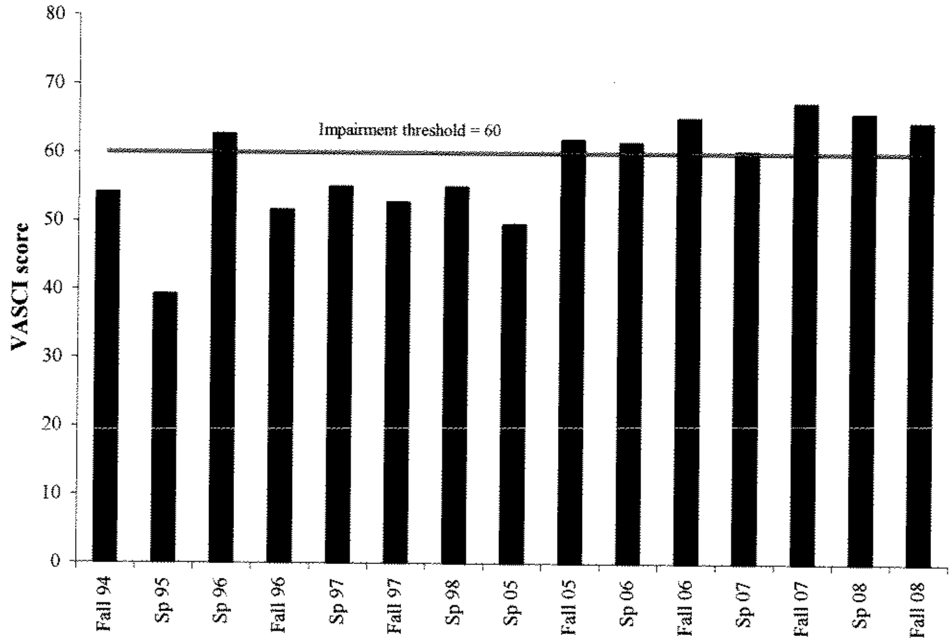

Figure 2.3 VASCI biological monitoring scores for VADEQ benthic monitoring station 2-JMS110.44 on the James River in Richmond, VA.

2.3 Habitat Assessments

Benthic impairments have two general causes: input of pollutants to streams and alteration of habitat in either the stream or the watershed. Habitat can be altered directly (*e.g.*, by channel modification), indirectly (because of changes in the riparian corridor leading to conditions such as streambank destabilization), or even more indirectly (*e.g.*, due to land use changes in the watershed such as clearing large areas).

Habitat assessments are normally carried out as part of the benthic sampling. The overall habitat score is the sum of ten individual metrics, each metric ranging from 0 to 20. The classification schemes for both the individual habitat metrics and the overall habitat score for a sampling site are shown in Table 2.5.

Table 2.5 Classification of habitat metrics based on score.

Habitat Metric	Optimal	Sub-optimal	Marginal	Poor
Embeddedness	16 - 20	11 – 15	6 - 10	0 - 5
Epifaunal Substrate	16 - 20	11 – 15	6 - 10	0 - 5
Pool Sediment	16 - 20	11 – 15	6 - 10	0 - 5
Flow	16 - 20	11 – 15	6 - 10	0 - 5
Channel Alteration	16 - 20	11 – 15	6 - 10	0 - 5
Riffles	16 - 20	11 – 15	6 - 10	0 - 5
Velocity	16 - 20	11 – 15	6 - 10	0 - 5
Bank Stability	18 - 20	12 – 16	6 - 10	0 - 4
Bank Vegetation	18 - 20	12 – 16	6 - 10	0 - 4
Riparian Vegetation	18 - 20	12 – 16	6 - 10	0 - 4

2.3.1 Habitat Assessment at Biological Monitoring Stations – James River in Richmond, VA

Habitat assessment for the James River includes an analysis of habitat scores recorded by the VADEQ biologist at the two-benthic monitoring stations. The VADEQ habitat assessments for 2-JMS110.34 are displayed in Table 2.6. Riparian Vegetation is a measure of the width of the natural riparian zone. A healthy riparian zone acts as a buffer for pollutants running off the land, helps prevent erosion, and provides habitat. The Riparian Vegetation around this monitoring station consistently scored in the poor category. The Bank Vegetation metric scored in the poor category in most of the surveys. A marginal score for this habitat metric means that less than 50% of the stream bank is covered by vegetation. The Channel Alteration metric scored in the marginal category in both the spring and fall 2005 surveys. Channel Alteration is a measure of how much the channel has been disturbed.

Table 2.6 Habitat scores for VADEQ monitoring station 2-JMS110.34 on the James River in Richmond, VA.

Habitat Metric	11/02/94	06/23/95	05/08/96	10/18/96	06/02/97	11/07/97	05/16/05	11/17/05	05/23/06	12/14/06	05/25/07	09/25/07	06/03/08	11/06/08
Bank Stability	10	10	10	10	10	10	19	18	17	19	19	18	19	19
Bank Vegetation	2	2	2	2	2	2	3	6	5	5	5	9	7	5
Channel Alteration	0	0	0	0	0	0	6	9	12	15	14	11	16	11
Embeddedness	12	12	12	12	12	12	8	11	13	15	16	9	14	14
Epifaunal Substrate	16	16	16	16	16	16	15	12	10	12	13	8	15	12
Flow	12	12	12	12	12	12	19	19	19	19	19	17	19	17
Pool Sediment	10	10	10	10	10	10	14	17	14	16	17	11	16	16
Riffles	12	12	12	12	12	12	18	19	19	20	20	17	20	20
Riparian Vegetation	2	2	2	2	2	2	2	3	5	4	4	6	6	5
Velocity	16	16	16	16	16	16	18	19	19	19	19	16	19	18
Total	**92**	**92**	**92**	**92**	**92**	**92**	**122**	**133**	**133**	**144**	**146**	**122**	**151**	**137**

Table 2.7 shows the habitat scores for the benthic surveys at station 2-JMS110.44. Habitat conditions at this monitoring station were nearly identical to those at station 2-JMS110.34.

Table 2.7 Habitat scores for VADEQ monitoring station 2-JMS110.44 on the James River in Richmond, VA.

Habitat Metric	11/07/94	06/23/95	05/08/96	10/18/96	06/02/97	11/07/97	05/22/98	05/16/05	11/17/05	05/23/06	12/14/06	05/25/07	9/25/07	6/3/08	11/6/08
Bank Stability	8	8	8	8	8	8	8	19	18	17	19	19	18	19	19
Bank Vegetation	6	6	6	6	6	6	6	3	6	5	5	5	9	7	5
Channel Alteration	6	6	6	6	6	6	6	6	9	12	15	15	11	16	11
Embeddedness	13	13	13	13	13	13	13	11	9	13	13	14	9	13	13
Epifaunal Substrate	12	12	12	12	12	12	12	16	15	14	12	14	11	14	14
Flow	10	10	10	10	10	10	10	19	19	19	18	18	17	17	17
Pool Sediment	9	9	9	9	9	9	9	15	12	14	12	15	11	12	15
Riffles	12	12	12	12	12	12	12	19	19	19	19	19	18	20	19
Riparian Vegetation	5	5	5	5	5	5	5	2	3	5	4	4	6	6	5
Velocity	14	14	14	14	14	14	14	18	19	19	19	18	15	19	18
Total	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**128**	**129**	**137**	**136**	**141**	**125**	**143**	**136**

2.4 Discussion of In-stream Water Quality

This section provides an inventory of available observed in-stream water quality data throughout the James River at Richmond. An examination of data from water quality stations used in the Section 305(b) assessment were analyzed and discussed.

Inventory of Water Quality Monitoring Data

The primary source of available water quality information for the James River at Richmond, VA is data collected by VADEQ at ambient monitoring stations.

VADEQ has monitored water quality recently at 16 stations on the James River at Richmond, VA in the vicinity of the impaired segment (Table 2.8). The locations of these stations are shown in Figure 2.1. The conventional data is summarized in Tables 2.9 through 2.24.

Table 2.8 VADEQ ambient water quality monitoring stations on the James River at Richmond, VA.

Station	Type	Data Record	Descriptive location
2-JMS110.30	Trend	1/1980 – 2/2008	Rt. 360 Bridge
2-JMS110.31	Special Study	6/1994 – 8/2001	James River,Mayos Br., North Channel
2-JMS110.34	Watershed	1/2007 – 4/2008	South Bank of the James River Below Fall Zone
2-JMS110.44	Watershed	1/2007 – 4/2008	North Bank James River Below Fall Zone
2-JMS110.49	Special Study	9/1995 – 8/2001	James River at Downstream End of Haxall
2-JMS110.90	Special Study	6/1994 – 9/1996	James River, Mancherster Br. Near South
2-JMS111.17	Special Study	9/1995 – 11/2007	James River, at Tredegar Iron Works
2-JMS111.32	Special Study	6/1994 – 8/2201	James River, Downstream Parkhydro CSO
2-JMS111.35	Special Study	7/1994 – 8/2001	James River,Upstream Parkhydro CSO, North
2-JMS111.47	Special Study	7/1994 – 11/2007	James River, North Bank of Belle Isle
2-JMS111.48	Special Study	6/1994 – 8/2001	James River,Downstream Canoe Run CSO, South
2-JMS111.55	Special Study	6/1994 – 8/2001	James River, Upstream Ocanoe Rin CSO, South
2-JMS112.33	Special Study	9/1995 – 11/2007	James River at Texas Avenue Beach
2-JMS112.37	Special Study	9/1995 – 8/2001	James River at Mouth of Reedy Creek
2-JMS112.79	Special Study	9/1995 – 11/2007	James River, 676m Above mouth of Reedy Creek
2-JMS113.20	Watershed	5/2006 – 5/2008	Boulevard Bridge

Table 2.9 In-stream water quality data at 2-JMS110.30 in the James River (1/1980 – 2/2008).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	50.8	14.4	82.9	9.2	49.8	160
Ammonia + Ammonium, Dissolved (mg/L as N)	0.03	0.03	0.20	0.00	0.03	207
Ammonia + Ammonium, Total (mg/L as N)	0.07	0.05	0.25	0.01	0.05	32
BOD5 (mg/L)	1.8	0.9	7.0	1.0	2.0	195
Calcium Total Ca (ug/l)	22,400	NA	22,400	22,400	NA	1
Carbon, Total Organic (mg/l)	5.1	3.3	29.0	1.0	4.4	324
Chloride,Total (mg/L)	12.2	12.7	141.0	2.4	9.6	142
COD Hi Level (mg/l)	12.1	6.9	75.0	1.0	11.0	214
COD Low Level (mg/l)	11.1	4.9	14.5	7.6	NA	2
Conductivity (µmhos/cm)	187	74	436	2	171	254
DO (mg/L)	10.3	2.1	16.3	6.5	10.0	246
Field_pH	7.9	0.7	9.3	6.1	8.0	247
Fluoride,Total (mg/L)	0.12	0.03	0.19	0.09	0.11	13
Magnesium Mg,Total (mg/l)	5,000	NA	5,000	5,000	NA	1
Mangnese Mn (ug/l)	80	95	280	10	35	8
Nitrate Nitrogen (mg/L as N)	0.28	0.13	0.52	0.04	0.28	126
Nitrate Nitrogen, Dissolved (mg/L as N)	0.20	0.15	0.60	0.00	0.21	271
Nitrite Nitrogen, Dissolved (mg/L as N)	0.01	0.01	0.06	0.00	0.00	80
Nitrite Nitrogen, Total (mg/L)	0.02	0.02	0.11	0.01	0.01	47
Nitrite Plus Nitrate, Dissolved (mg/L as N)	0.17	0.15	0.53	0.00	0.15	146
Nitrite Plus Nitrate, Total (mg/L as N)	0.28	NA	0.28	0.28	NA	1
Nitrogen, Kjeldahl, Dissolved (mg/L As N)	0.35	0.21	0.50	0.20	NA	2
Nitrogen, Kjeldahl, Total (mg/L As N)	0.38	0.30	3.50	0.10	0.30	309
Particulate Carbon (in ug)	15.7	8.5	42.4	3.3	13.0	71
Particulate Nitrogen (in ug)	2.7	2.3	9.5	1.1	1.8	15
Particulate Phosphorus (in ug)	0.23	0.27	2.15	0.07	0.18	63
Phosphorus (Dissolved Ortho P, mg/L)	0.06	0.06	0.46	0.00	0.04	458
Phosphorus (Total Ortho P, mg/L)	0.06	0.02	0.10	0.02	0.05	14
Phosphorus, Dissolved (mg/L As P)	0.08	0.07	0.48	0.01	0.06	169
Phosphorus, Total (mg/L As P)	0.14	0.11	1.20	0.02	0.10	268
Sulfate, Total (mg/L)	19.5	11.2	65.0	6.6	15.6	149
Tannin Lignin (mg/l)	0.74	NA	0.74	0.74	NA	1
Temp_Celsuis	16.7	8.8	32.5	0.5	16.9	247
Total Dissolved Solids, 105C (mg/L)	155	50	190	119	NA	2
Total Dissolved Solids, 180C (mg/L)	133	NA	133	133	NA	1
Total Hardness (CaCO3 mg/L)	78	244	3,600	21	59	212
Total Inorganic Solids (mg/L)	116	69	754	14	100	143
Total Inorganic Suspended Solids (mg/L)	22.6	52.5	640.0	0.0	7.0	306
Total Organic Solids (mg/L)	27.5	12.6	107.0	6.0	26.0	141
Total Organic Suspended Solids (mg/L)	5.8	7.4	78.0	0.0	3.8	238
Total Solids (mg/L)	145	77	861	74	125	143
Total Suspended Solids (TSS) (mg/L)	25.0	56.5	718.0	1.0	8.0	339
Turbidity HACH (FTU)	11.6	26.6	237.0	0.6	4.8	132
Turbidity Jackson (JTU)	21.7	39.2	180.0	0.6	5.4	64
Turbidity Lab (ntu)	23.3	44.6	223.0	1.2	6.1	61

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable..

Table 2.10 In-stream water quality data at 2-JMS110.31 in the James River (6/1994 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	50.8	12.6	69.0	32.3	49.3	6
Ammonia + Ammonium, Total (mg/L as N)	0.12	0.09	0.27	0.04	0.11	5
BOD5 (mg/L)	3.2	1.6	6.0	1.3	3.2	7
Carbon, Total Organic (mg/l)	5.4	NA	5.4	5.4	NA	1
Chloride,Total (mg/L)	13.7	5.4	20.8	8.2	11.8	6
Conductivity (μmhos/cm)	185	47	263	130	183	6
DO (mg/L)	8.8	0.9	10.9	7.4	8.7	45
Field_pH	8.1	0.3	8.7	7.4	8.1	45
Nitrate Nitrogen (mg/L as N)	0.23	0.10	0.34	0.10	0.26	5
Nitrite Nitrogen, Total (mg/L)	0.03	0.01	0.03	0.01	0.03	4
Nitrogen, Kjeldahl, Total (mg/L As N)	0.41	0.21	0.83	0.30	0.33	6
Phosphorus (Total Ortho P, mg/L)	0.09	0.06	0.22	0.05	0.08	6
Phosphorus, Total (mg/L As P)	0.12	0.06	0.25	0.06	0.11	6
Sulfate, Total (mg/L)	21.1	9.4	32.7	11.4	19.0	6
Temp_Celsuis	24.3	4.1	30.7	16.0	24.8	45
Total Inorganic Solids (mg/L)	98.5	31.9	133.0	53.0	103.8	6
Total Inorganic Suspended Solids (mg/L)	10.3	4.8	16.3	4.3	11.0	5
Total Organic Solids (mg/L)	32.0	12.1	41.5	16.0	38.5	6
Total Organic Suspended Solids (mg/L)	3.0	0.8	4.0	2.0	3.0	4
Total Solids (mg/L)	128.3	36.4	170.0	85.0	125.7	6
Total Suspended Solids (TSS) (mg/L)	11.4	6.0	20.3	4.0	11.0	6
Turbidity HACH (FTU)	7.8	4.1	12.8	1.8	7.1	6

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.11 In-stream water quality data at 2-JMS110.34 in the James River (1/2007 – 4/2008).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Ammonia + Ammonium, Total (mg/L as N)	0.04	NA	0.04	0.04	NA	1
BOD5 (mg/L)	3.45	1.29	5.00	2.00	4.00	11
Conductivity (μmhos/cm)	191.64286	65.01433	332	117	166	14
DO (mg/L)	11.31	2.19	14.80	8.10	11.15	14
Field_pH	7.89	0.47	8.80	7.20	7.75	14
Nitrate Nitrogen (mg/L as N)	0.24	0.12	0.36	0.04	0.28	8
Nitrite Nitrogen, Total (mg/L)	0.01	NA	0.01	0.01	NA	1
Nitrogen, Kjeldahl, Total (mg/L As N)	0.4	0.2	0.8	0.1	0.4	14
Phosphorus (Total Ortho P, mg/L)	0.02	0.00	0.03	0.02	0.02	9
Phosphorus, Total (mg/L As P)	0.0	0.1	0.2	0.0	0.0	14
Settleble Solids (ml/L)	0.8	NA	0.8	0.8	NA	1
Temp_Celsuis	14.0	9.8	29.7	2.7	11.2	14
Total Suspended Solids (TSS) (mg/L)	19.7	38.5	132.0	3.0	5.0	11

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.12 In-stream water quality data at 2-JMS110.44 in the James River (1/2007 – 4/2008).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Ammonia + Ammonium, Total (mg/L as N)	0.05	NA	0.05	0.05	NA	1
BOD5 (mg/L)	3.6	1.1	5.0	2.0	4.0	10
Conductivity (µmhos/cm)	191	66	333	107	165	14
DO (mg/L)	11.1	2.3	14.4	7.8	11.3	14
Field_pH	7.9	0.5	8.6	7.3	7.7	14
Nitrate Nitrogen, Total (mg/L as N)	0.26	0.11	0.40	0.05	0.29	8
Nitrite Nitrogen, Total (mg/L as N)	0.01	0.00	0.01	0.01	NA	2
Nitrogen, Kjeldahl, Total (mg/L As N)	0.44	0.22	0.80	0.10	0.40	14
Phosphorus (Total Ortho P, mg/L)	0.02	0.00	0.03	0.02	0.02	9
Phosphorus, Total (mg/L As P)	0.05	0.04	0.17	0.02	0.04	14
Settleble Solids (ml/L)	0.43	0.46	0.75	0.10	NA	2
Temp_Celsuis	14.4	9.6	30.1	3.2	11.6	14
Total Suspended Solids (TSS) (mg/L)	16.6	31.9	111.0	3.0	5.0	11

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.13 In-stream water quality data at 2-JMS110.49 in the James River (9/1995 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Conductivity (µmhos/cm)	216	62	374	126	191	35
DO (mg/L)	8.7	0.9	10.5	6.9	8.6	36
Field_pH	8.0	0.3	8.5	7.5	8.1	36
Temp_Celsuis	23.8	3.9	29.0	15.7	24.4	36

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.14 In-stream water quality data at 2-JMS110.90 in the James River (6/1994 – 9/1996).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	52.4	12.1	68.1	33.8	53.0	6
Ammonia + Ammonium, Total (mg/L as N)	0.05	0.01	0.06	0.05	0.05	3
BOD5 (mg/L)	1.9	0.7	3.3	1.2	1.9	7
Carbon, Total Organic (mg/l)	4.3	NA	4.3	4.3	NA	1
Chloride,Total (mg/L)	14.5	5.1	22.0	10.1	12.3	6
Conductivity (µmhos/cm)	194	45	260	142	189	6
DO (mg/L)	8.7	0.6	10.0	7.8	8.8	14
Field_pH	7.9	0.4	8.8	7.4	8.1	12
Nitrate Nitrogen, Total (mg/L as N)	0.20	0.11	0.33	0.06	0.22	5
Nitrite Nitrogen, Total (mg/L as N)	0.02	0.01	0.03	0.01	0.03	4
Nitrogen, Kjeldahl, Total (mg/L As N)	0.33	0.10	0.50	0.25	0.30	6
Phosphorus (Total Ortho P, mg/L)	0.06	0.02	0.09	0.04	0.06	6
Phosphorus, Total (mg/L As P)	0.08	0.02	0.13	0.05	0.08	6
Sulfate, Total (mg/L)	21.9	9.4	34.7	12.2	19.9	6
Temp_Celsuis	24.0	4.6	31.1	16.1	24.5	14
Total Inorganic Solids (mg/L)	106.9	28.9	146.0	71.0	96.8	6
Total Inorganic Suspended Solids (mg/L)	6.0	3.0	11.0	3.5	5.5	5
Total Organic Solids (mg/L)	34.6	10.5	48.0	23.0	32.9	6
Total Organic Suspended Solids (mg/L)	2.2	0.8	3.0	1.5	2.0	3
Total Solids (mg/L)	141.5	29.5	186.0	116.0	129.8	6
Total Suspended Solids (TSS) (mg/L)	6.8	3.6	13.5	3.0	6.3	6
Turbidity HACH (FTU)	5.3	3.1	10.3	1.8	4.8	6

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.15 In-stream water quality data at 2-JMS111.17 in the James River (9/1995 – 11/2007).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	53.9	13.1	68.8	32.7	56.5	5
Ammonia + Ammonium, Total (mg/L as N)	0.05	0.01	0.06	0.04	NA	2
BOD5 (mg/L)	3.0	0.0	3.0	3.0	NA	2
Carbon, Total Organic (mg/l)	6.4	2.3	10.3	4.7	5.5	5
Chloride,Total (mg/L)	11.7	3.6	15.4	8.5	11.4	4
COD Hi Level (mg/l)	12.3	4.0	17.2	6.3	12.3	5
Conductivity (µmhos/cm)	210	71	301	112	203	5
DO (mg/L)	9.1	1.8	14.6	5.6	8.8	61
Field_pH	7.9	0.3	8.4	6.9	7.9	61
Nitrate Nitrogen, Total (mg/L as N)	0.22	0.14	0.43	0.04	0.19	5
Nitrite Nitrogen, Total (mg/L as N)	0.01	0.00	0.02	0.01	0.01	3
Nitrogen, Kjeldahl, Total (mg/L As N)	0.38	0.21	0.72	0.17	0.35	5
Phosphorus (Total Ortho P, mg/L)	0.04	0.03	0.09	0.02	0.04	5
Phosphorus, Total (mg/L As P)	0.09	0.07	0.20	0.03	0.07	4
Sulfate, Total (mg/L)	23.7	12.7	40.1	8.3	21.2	5
Temp_Celsuis	21.0	7.6	32.5	3.5	23.2	63
Total Hardness (CaCO3 mg/L)	63.2	8.3	73.4	52.2	61.1	5
Total Inorganic Solids (mg/L)	111.1	39.1	155.2	61.0	107.0	5
Total Inorganic Suspended Solids (mg/L)	15.7	19.9	45.5	5.0	6.1	4
Total Organic Solids (mg/L)	30.6	5.8	35.6	23.0	34.3	5
Total Organic Suspended Solids (mg/L)	7.1	6.3	14.3	3.3	3.8	3
Total Solids (mg/L)	141.7	43.5	190.8	84.0	132.7	5
Total Suspended Solids (TSS) (mg/L)	16.8	22.3	56.5	4.0	7.0	5
Turbidity HACH (FTU)	13.8	13.6	37.6	4.2	10.8	5

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.16 In-stream water quality data at 2-JMS111.32 in the James River (6/1994 – 8/2201).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	46.6	12.2	64.1	31.7	50.6	11
Ammonia + Ammonium, Total (mg/L as N)	0.23	0.33	0.90	0.04	0.10	6
BOD5 (mg/L)	3.0	1.5	5.2	1.4	2.3	8
Carbon, Total Organic (mg/l)	10.9	9.2	28.2	4.0	7.0	6
Chloride,Total (mg/L)	12.4	4.5	20.5	7.3	12.3	10
COD Hi Level (mg/l)	14.6	4.0	19.0	9.5	14.9	4
Conductivity (µmhos/cm)	176	49	240	113	186	11
DO (mg/L)	6.4	2.2	11.7	1.6	6.7	48
Field_pH	7.3	0.4	8.1	6.7	7.3	48
Nitrate Nitrogen, Total (mg/L as N)	0.23	0.09	0.42	0.10	0.24	10
Nitrite Nitrogen, Total (mg/L as N)	0.02	0.01	0.05	0.01	0.02	10
Nitrogen, Kjeldahl, Total (mg/L As N)	0.46	0.26	1.15	0.20	0.43	11
Phosphorus (Total Ortho P, mg/L)	0.05	0.03	0.12	0.03	0.05	11
Phosphorus, Total (mg/L As P)	0.09	0.05	0.18	0.04	0.09	10
Sulfate, Total (mg/L)	19.0	8.5	32.4	8.7	21.5	11
Temp_Celsuis	22.4	5.9	30.1	5.0	23.9	49
Total Hardness (CaCO3 mg/L)	65.8	9.9	76.6	53.4	66.7	4
Total Inorganic Solids (mg/L)	97.8	30.9	141.0	58.0	97.8	11
Total Inorganic Suspended Solids (mg/L)	9.8	6.1	21.5	3.0	8.8	10
Total Organic Solids (mg/L)	29.1	7.6	40.5	16.0	28.0	11
Total Organic Suspended Solids (mg/L)	6.0	4.7	15.0	1.7	5.1	6
Total Solids (mg/L)	127.5	35.3	179.0	81.0	129.8	11
Total Suspended Solids (TSS) (mg/L)	11.1	7.1	25.0	3.0	9.0	11
Turbidity HACH (FTU)	13.9	12.1	40.9	2.7	8.2	11

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.17 In-stream water quality data at 2-JMS111.35 in the James River (7/1994 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	51.7	12.5	68.4	32.8	52.3	6
Ammonia + Ammonium, Total (mg/L as N)	0.08	0.02	0.10	0.06	0.07	4
BOD5 (mg/L)	2.3	1.6	5.4	1.1	1.6	6
Carbon, Total Organic (mg/l)	3.9	NA	3.9	3.9	NA	1
Chloride,Total (mg/L)	13.5	5.7	20.7	6.2	12.1	6
Conductivity (µmhos/cm)	186	48	258	120	185	6
DO (mg/L)	8.7	0.9	10.8	6.4	8.6	44
Field_pH	8.0	0.3	8.4	7.5	8.0	44
Nitrate Nitrogen, Total (mg/L as N)	0.21	0.10	0.34	0.09	0.24	5
Nitrite Nitrogen, Total (mg/L as N)	0.03	0.01	0.03	0.01	0.03	4
Nitrogen, Kjeldahl, Total (mg/L As N)	0.33	0.04	0.40	0.30	0.30	6
Phosphorus (Total Ortho P, mg/L)	0.06	0.01	0.08	0.05	0.06	6
Phosphorus, Total (mg/L As P)	0.08	0.01	0.11	0.07	0.08	6
Sulfate, Total (mg/L)	20.9	9.5	32.7	10.5	19.1	6
Temp_Celsuis	24.0	4.1	30.4	15.6	24.7	44
Total Inorganic Solids (mg/L)	101.6	34.4	145.0	60.0	97.7	6
Total Inorganic Suspended Solids (mg/L)	5.9	2.6	10.5	3.0	5.2	6
Total Organic Solids (mg/L)	26.2	6.3	33.5	19.0	25.5	6
Total Organic Suspended Solids (mg/L)	2.1	0.8	3.0	1.5	1.7	3
Total Solids (mg/L)	127.8	35.2	168.0	79.0	122.7	6
Total Suspended Solids (TSS) (mg/L)	7.1	3.1	12.5	3.5	6.8	6
Turbidity HACH (FTU)	6.0	2.8	9.9	2.7	5.8	6

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.18 In-stream water quality data at 2-JMS111.47 in the James River (7/1994 – 11/2007).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Conductivity (µmhos/cm)	205	57	359	107	190	69
DO (mg/L)	9.5	1.9	15.5	6.8	9.0	69
Field_pH	8.0	0.4	9.0	7.2	8.0	69
Temp_Celsuis	21.3	7.4	33.1	3.2	23.1	70

[1]SD: standard deviation, [2]N: number of sample measurements.

Table 2.19 In-stream water quality data at 2-JMS111.48 in the James River (6/1994 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	43.6	15.5	69.2	31.0	35.9	6
Ammonia + Ammonium, Total (mg/L as N)	0.37	0.24	0.56	0.08	0.52	5
BOD5 (mg/L)	6.9	4.4	13.5	2.2	4.7	7
Carbon, Total Organic (mg/l)	14.2	NA	14.2	14.2	NA	1
Chloride,Total (mg/L)	10.0	5.4	19.1	5.3	7.9	6
Conductivity (µmhos/cm)	140	36	207	101	132	6
DO (mg/L)	5.0	2.6	10.5	0.2	5.4	45
Field_pH	7.0	0.4	7.9	6.4	7.0	45
Nitrate Nitrogen, Total (mg/L as N)	0.21	0.11	0.33	0.05	0.19	5
Nitrite Nitrogen, Total (mg/L as N)	0.03	0.01	0.05	0.01	0.04	5
Nitrogen, Kjeldahl, Total (mg/L As N)	0.83	0.42	1.30	0.40	0.83	6
Phosphorus (Total Ortho P, mg/L)	0.12	0.06	0.21	0.06	0.11	6
Phosphorus, Total (mg/L As P)	0.20	0.14	0.46	0.10	0.15	6
Sulfate, Total (mg/L)	14.6	7.0	28.2	9.1	12.6	6
Temp_Celsuis	21.2	4.1	27.5	11.6	21.8	45
Total Inorganic Solids (mg/L)	85.9	30.4	138.0	62.5	71.3	6
Total Inorganic Suspended Solids (mg/L)	12.4	7.3	23.0	5.0	10.3	6
Total Organic Solids (mg/L)	26.3	11.5	47.0	12.0	24.4	6
Total Organic Suspended Solids (mg/L)	7.4	3.3	10.5	3.0	8.3	5
Total Solids (mg/L)	112.0	38.3	166.0	77.0	95.6	6
Total Suspended Solids (TSS) (mg/L)	18.5	10.4	31.3	6.0	18.0	6
Turbidity HACH (FTU)	13.2	5.3	21.3	5.9	12.9	6

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.20 In-stream water quality data at 2-JMS111.55 in the James River (6/1994 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Alkalinity, Total (mg/L)	53.2	24.4	97.2	27.9	51.4	6
Ammonia + Ammonium, Total (mg/L as N)	0.06	0.01	0.06	0.05	NA	2
BOD5 (mg/L)	1.8	0.9	3.5	1.1	1.5	7
Carbon, Total Organic (mg/l)	5.4	NA	5.4	5.4	NA	1
Chloride,Total (mg/L)	11.4	5.4	20.1	6.1	11.4	6
Conductivity (µmhos/cm)	160	39	201	109	167	6
DO (mg/L)	7.3	1.9	12.6	2.6	7.2	45
Field_pH	7.3	0.5	8.8	6.5	7.2	45
Nitrate Nitrogen, Total (mg/L as N)	0.20	0.07	0.26	0.13	0.20	4
Nitrite Nitrogen, Total (mg/L as N)	0.02	0.01	0.03	0.01	0.03	5
Nitrogen, Kjeldahl, Total (mg/L As N)	0.31	0.07	0.40	0.20	0.32	6
Phosphorus (Total Ortho P, mg/L)	0.05	0.02	0.07	0.03	0.05	6
Phosphorus, Total (mg/L As P)	0.07	0.01	0.09	0.05	0.07	6
Sulfate, Total (mg/L)	17.5	8.4	31.6	9.9	16.2	6
Temp_Celsuis	22.0	4.4	28.9	13.0	22.9	45
Total Inorganic Solids (mg/L)	89.7	38.2	155.0	58.0	81.0	6
Total Inorganic Suspended Solids (mg/L)	7.4	6.2	18.0	3.0	5.0	5
Total Organic Solids (mg/L)	26.2	8.1	39.0	18.0	23.0	6
Total Organic Suspended Solids (mg/L)	2.3	1.5	4.0	1.0	2.0	4
Total Solids (mg/L)	116.1	40.6	188.0	76.0	112.8	6
Total Suspended Solids (TSS) (mg/L)	6.5	4.0	13.0	3.0	4.5	6
Turbidity HACH (FTU)	5.5	4.3	13.5	2.4	3.9	6

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

Table 2.21 In-stream water quality data at 2-JMS112.33 in the James River (9/1995 – 11/2007).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Conductivity (µmhos/cm)	216	111	962	109	191	61
DO (mg/L)	9.2	2.0	14.6	4.9	8.7	61
Field_pH	7.7	0.4	8.9	6.9	7.6	60
Temp_Celsuis	20.8	7.2	34.0	4.0	22.7	61

[1]SD: standard deviation, [2]N: number of sample measurements.

Table 2.22 In-stream water quality data at 2-JMS112.37 in the James River (9/1995 – 8/2001).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Conductivity (µmhos/cm)	184	46	305	81	181	34
DO (mg/L)	6.3	2.0	9.4	0.9	6.7	35
Field_pH	7.1	0.4	8.0	6.5	7.0	35
Temp_Celsuis	21.2	3.6	26.4	13.8	22.1	35

[1]SD: standard deviation, [2]N: number of sample measurements.

Table 2.23 In-stream water quality data at 2-JMS112.79 in the James River (9/1995 – 11/2007).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Conductivity (µmhos/cm)	203	55	359	104	190	61
DO (mg/L)	9.3	2.0	15.8	6.8	8.8	61
Field_pH	7.8	0.4	8.9	6.7	7.8	61
Temp_Celsuis	20.6	7.3	32.2	2.9	22.6	62

[1]SD: standard deviation, [2]N: number of sample measurements.

Table 2.24 In-stream water quality data at 2-JMS113.20 in the James River (5/2006 – 5/2008).

Water Quality Constituent	Mean	SD[1]	Max	Min	Median	N[2]
Ammonia + Ammonium, Total (mg/L as N)	0.02	0.02	0.08	0.01	0.02	9
Carbon, Organic Dissolved Field Filtered (mg/l)	3.9	0.8	5.2	2.7	3.8	11
Carbon, Organic Suspended Inorganic (mg/l)	0.03	NA	0.03	0.03	NA	1
Conductivity (µmhos/cm)	189	69	338	101	162	25
DO (mg/L)	10.9	2.4	15.3	7.1	11.3	23
Field_pH	7.9	0.5	8.8	7.3	7.8	24
Nitrate Nitrogen, Dissolved (mg/L as N)	0.13	0.09	0.24	0.01	0.14	10
Nitrite Nitrogen, Dissolved (mg/L as N)	0.00	0.00	0.01	0.00	0.00	4
Nitrite Plus Nitrate, Dissolved (mg/L as N)	0.14	0.09	0.25	0.01	0.14	10
Nitrite Plus Nitrate, Total (mg/L as N)	0.26	0.08	0.36	0.10	0.27	12
Nitrogen, Kjeldahl, Total (mg/L As N)	0.34	0.18	0.60	0.10	0.30	13
Particulate Carbon, Lab Filtered (mg/l)	1.0	1.2	3.4	0.3	0.6	10
Particulate Nitrogen, Lab filtered (mg/l)	0.08	0.05	0.21	0.05	0.07	8
Particulate Phosphorus, Lab Filtered (mg/l)	0.02	0.03	0.07	0.00	0.01	10
Phosphorus (Dissolved Ortho P (mg/L))	0.01	0.01	0.02	0.01	0.01	11
Phosphorus (Dissolved Ortho P Lab Filtered (mg/L))	0.01	0.01	0.03	0.00	0.01	14
Phosphorus, Suspended Inorganic Lab Filtered (mg/l as p)	0.01	0.01	0.03	0.00	0.01	10
Phosphorus, Total (mg/L As P)	0.10	0.11	0.52	0.02	0.05	24
Susp. Sed. Conc. - <62 um (mg/L), (Method C)	69.6	147.9	656.0	1.5	17.7	19
Susp. Sed. Conc. - >62 um (mg/L), (Method C)	39.8	88.2	367.0	0.3	7.2	18
Temp_Celsuis	15.8	8.5	29.9	2.6	13.5	24
Total Dissolved Nitrogen, Lab Filtered (mg/l)	0.33	0.13	0.59	0.18	0.29	10
Total Dissolved Phosphorus, Lab Filtered (mg/l)	0.02	0.01	0.04	0.01	0.02	10
Total Inorganic Solids (mg/L)	46.4	80.4	367.0	4.0	19.0	20
Total Inorganic Suspended Solids (mg/L)	37.4	72.9	327.0	3.0	13.0	19
Total Nitrogen as N (mg/L)	0.5	0.3	1.8	0.2	0.5	24
Total Organic Suspended Solids (mg/L)	10.7	9.1	21.0	4.0	7.0	3
Turbidity Lab (ntu)	9.2	11.9	41.1	1.4	5.0	10

[1]SD: standard deviation, [2]N: number of sample measurements, NA: not applicable.

2.4.1.1 Sediment Sampling Results in the James River at Richmond, VA

VADEQ performed special study sediment sampling at two sites and one in-stream sediment sampling at station on the James River at Richmond, VA. These stations are described in Table 2.25 and shown in Figure 2.1. Sediment samples were tested for PCBs, various pesticides and organic chemicals, and metals.

Table 2.25 VADEQ special study sediment and in-stream sediment water quality monitoring stations on the James River at Richmond, VA.

Station	Type	Data Records	Descriptive location
2-JMS110.00	Sediment PCBs, Sediment Pesticides, Sediment Organics, Sediment PAHs, Sediment Metals	9/24/2001	Near I-95 bridge
2-JMS110.30	Sediment metals	9/11/1980, 5/6/1981, 8/27/1992	Rt. 360 Bridge
2-JMS113.29	Sediment PCBs, Sediment Pesticides, Sediment Organics, Sediment PAHs, Sediment Metals	8/2/1996	James River

Table 2.26 In-stream sediment sampling results for metals from three VADEQ monitoring stations on the James River at Richmond, VA.

Metal	PEC[1] (mg/Kg)	2-JMS110.30 9/11/1980	2-JMS110.30 5/6/1981	2-JMS110.30 8/27/1992	2-JMS113.29 8/2/1996	2-JMS110.00 9/24/2001
Aluminum					0.35	0.84
Silver	2.6				0.034	<0.02
Arsenic	33				1.7	<0.5
Cadmium	4.98				0.066	0.12
Chromium	111	13.9	14.5	25	7.5	18
Copper	149	3.39	4.37	14	4.9	29
Mercury	1.06				<0.01	0.15
Nickel	48.6	9.33	3.5	14	1.5	8.5
Lead	128	4.68	21.2	13	4.5	19
Antimony					<0.5	<0.5
Selenium					<0.5	<0.5
Thallium					<0.3	<0.3
Zinc	459	42.1	34.2	86	45	66

[1]PEC = Probable Effect Concentration (McDonald, 2000); all metals values are in mg/Kg.

In-stream sediment samples were tested for poly aromatic hydrocarbons at two stations on the James River at Richmond, VA. All sediment results were below PEC values (Table 2.27). Pesticides were also sampled at the same two stations, and all samples were below minimum laboratory detection levels.

Table 2.27 Special study sediment PAH results from the James River at Richmond, VA.

Total	PEC[1] (ug/Kg)	VA 99th Percentile (ug/Kg)	2-JMS113.39 8/2/1996 (ug/Kg)	2-JMS110.00 9/24/2001 (ug/Kg)
Napthalene	561			2.43
Di-methylnapthalene		83		4.97
Methylnapthalene				3.32
Biphenyl				0.38
2,6 Dimethylnapthalene		170		14.66
Acenaphthylene		121		0.34
Acenaphthene				0.47
2,3,5-Trimethylnaphthalene				2.50
Fluorene	536			2.00
Phenanthrene	1,170			9.79
Anthracene	845			1.41
Methylphenanthrene				1.47
Fluoranthene	2,230		43.34	22.20
Pyrene	1,520		36.73	17.81
Benzo[a]anthracene	1,050		37.35	14.06
Chrysene	1,290		34.61	20.59
Benzo[b]fluoranthene			37.6	21.09
Benzo[k]fluoranthene			41.97	19.13
Benzo[e]pyrene			32.53	15.82
Benzo[a]pyrene	1,450		41.39	14.06
Perylene				15.54
Indeno(1,2,3-cd)pyrene			30.48	12.39
Dibenzo(a,h)anthracene		318		5.74
Benzo(ghi)perylene			26.1	10.61

[1]PEC = Probable Effect Concentration (McDonald, 2000); VADEQ 99th percentile = VADEQ screening value.

2.4.1.2 Dissolved Metals Sampling Results From the James River at Richmond, VA

Dissolved metals were not collected at any of the VADEQ monitoring stations listed in table 2.2.

2.4.1.3 Combined Sewer Overflows (CSOs) in the City of Richmond

VADEQ benthic monitoring stations 2-JMS110.34 and 2-JMS110.44 were established to monitor the potential impact from a series of CSOs from the City of Richmond. In a portion of the City of Richmond, the sanitary sewer also collects stormwater runoff from areas adjacent to the James River and stream flow from some tributaries. This type of system is referred to as a combined sewer system (CSS). The amount of runoff and stream flow from these areas is dependent on rainfall. Depending on the CSO between ½ to ¾ inches of rain can potentially produce a combined sewer system discharge. On a dry flow day (no recent rainfall), the James River Wastewater Treatment Plant (WWTP) treats this flow. During heavy rainfall the system may fill to capacity, and the James River Wastewater Treatment Plant (WWTP) cannot treat the entire volume; therefore, overflows occur. These combined sewer overflows (CSOs) are a part of VPDES permit number VA0063177. CSO number 040 discharges from a diffuser installed in the center of the south stream channel to minimize any potential impacts from the discharge. CSO number 040 is approximately 1,771 feet upstream from benthic monitoring station 2-110.34. Table 2.28 summarizes the current CSOs within and just upstream of the impaired aquatic life segment on the James River. The City of Richmond has an ongoing CSO program to reduce the number of overflows at each location each year, upgrade the wastewater treatment plant, and pre-treat the combined water (City of Richmond and Greeley and Hansen, 2006). Figure 2.4 shows the locations of these CSOs.

Table 2.28 Combined Sewer Overflows (CSOs) discharge locations currently included in permit #VA0063649.

Outfall Number	Outfall Name	Location
007	Byrd Street	Byrd Street, between 12th and 13th Streets
009	7th Street	7th and Bragg Streets
010	Gambles Hill	Tredegar Street, West of 7th St.
011	Park Hydro Station	Tredegar Street, West of Lee Bridge
015	Canoe Run	Next to Southern Railway Line, north of Riverside Drive and 22nd Street
016	Woodland Heights	Next to Southern Railway Line, north of Riverside Drive and 26th Street
017	Reedy Creek	Next to Southern Railway Line, approx. north of Riverside Drive
018	42nd Street	Next to Southern Railway Line, north of Riverside Drive and 42nd Street
019	Hampton Street and Colorado	New York Avenue, between Hampton Street and Meadow Avenue
020	McCloy Street	McCloy Street
033	Shields Lake	Park Drive and Shields Lake
040	CSO-1 Outlet	1250 ft. downstream of the Manchester Bridge

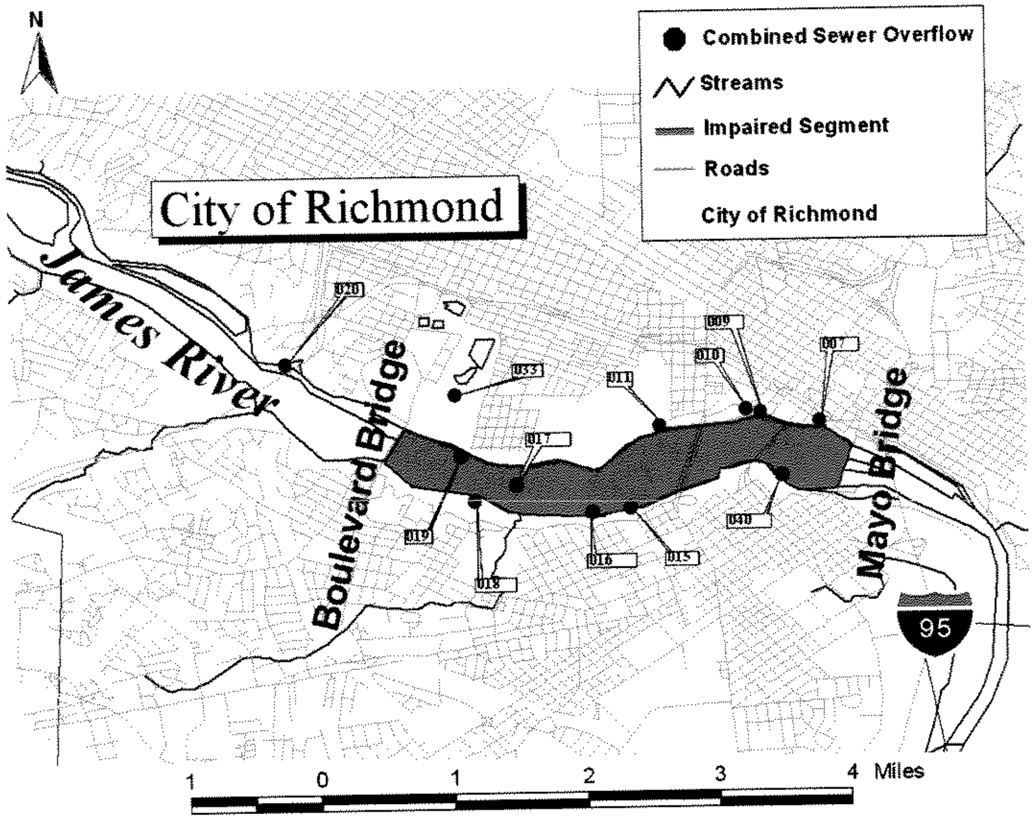

Figure 2.4 **Combined Sewer Overflows (CSOs) discharge locations.**

3. TMDL ENDPOINT: STRESSOR IDENTIFICATION – JAMES RIVER AT RICHMOND, VA

The James River begins in Botetourt County and flows in a predominately eastern direction until it reaches the Chesapeake Bay. The James River is the largest river basin the Virginia. The drainage area at the VADEQ flow gage at the Richmond City locks, just downstream from the impaired benthic segment, is 6,798 square miles. The impaired benthic segment begins at the Boulevard Bridge and continues downstream to the fall line near the Mayo Bridge for a distance of 2.99 stream miles.

The stressor analysis was performed by first comparing the data collected at the long term VADEQ monitoring station 2-JMS110.30 just downstream from the impaired benthic monitoring station (2-JMS110.34) with the appropriate water quality standards and screening values. In addition, a comparison was made with a long term VADEQ monitoring station 2-JMS117.35 located upstream from a non-impaired benthic monitoring station. Comparison graphs are shown for most parameters and graphs showing the standards and screening values are included in the appendix. The data is compared using "box and whisker" plots. Interpretation of the plots is illustrated in Figure 3.1, in which the data range for a given metric is displayed as four quartiles. The "box" of two colors shows the two inner quartiles with the dividing line between the colors representing the median value. The "whiskers" above and below each box show the outer quartiles with the upper quartile extending above the box and the lower quartile extending below the box. Finally, the mean value is displayed as a square within one of the two inner-quartile boxes.

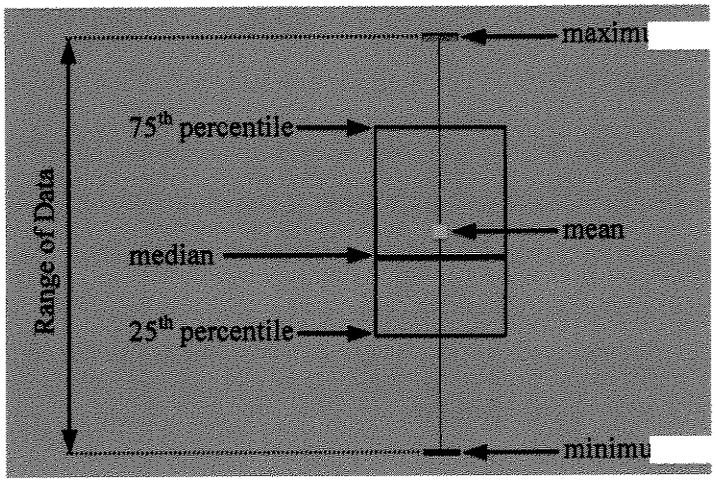

Figure 3.1 Interpretation of Box and Whisker plots.

VADEQ began collecting water quality data at the impaired benthic monitoring station and at the formerly impaired benthic monitoring station (2-JMS110.44) in January 2007. Because the impaired segment was first listed in 1996, it was decided that using the long term monitoring stations for the stressor analysis was the most appropriate thing to do. The recent data collected at the benthic monitoring stations in the impaired segment were compared to and found to be consistent with the long term monitoring stations noted above.

TMDLs must be developed for a specific pollutant(s). Benthic assessments are very good at determining if a particular stream segment is impaired or not, but they usually do not provide enough information to determine the cause(s) of the impairment when organisms are not classified beyond the family level. The process outlined in the Stressor Identification Guidance Document (EPA, 2000b) was used to separately identify the most probable stressor(s) for the Jackson River. A list of candidate causes was developed from published literature and VADEQ staff input. Chemical and physical monitoring data provided evidence to support or eliminate potential stressors. Individual metrics for the biological and habitat evaluation were used to determine if there were links to a specific stressor(s). Land use data as well as a visual assessment of conditions along the stream provided additional information to eliminate or support candidate stressors. The potential stressors are: sediment, toxics, low dissolved oxygen, nutrients, pH, metals, temperature, organic matter and combined sewer overflows (CSOs).

The results of the stressor analysis for the James River are divided into three categories:

Non-Stressor(s): Those stressors with data indicating normal conditions, without water quality standard violations, or without the observable impacts usually associated with a specific stressor, were eliminated as possible stressors. Non-stressors are listed in Table 3.1.

Possible Stressor(s): Those stressors with data indicating possible links, but inconclusive data, were considered to be possible stressors. Possible stressors are listed in Table 3.2.

Most Probable Stressor(s): The stressor(s) with the most consistent information linking it with the poorer benthic and habitat metrics was considered to be the most probable stressor(s). Most probable stressors are discussed in section 3.3.

3.1 Non-Stressors

Table 3.1 Non-Stressors in the James River.

Parameter	Location in Document
Low dissolved oxygen	Section 3.1.1
Toxics (ammonia, pesticides, PCBs and polycyclic aromatic hydrocarbons (PAHs))	Section 3.1.2
Metals (sediment)	Section 3.1.3
Temperature	Section 3.1.4
Sediment	Section 3.1.5
Organic Matter	Section 3.1.6

There is always a possibility that conditions in the watershed, available data, and the understanding of the natural processes change more than anticipated by the TMDL. If additional monitoring shows that different most probable stressor(s) exist or water quality target(s) are protective of water quality standards (WQS), then the Commonwealth will make use of the option to refine the TMDLs for re-submittal to EPA for approval.

3.1.1 Low Dissolved Oxygen

Dissolved oxygen (DO) concentrations were well above the water quality minimum standard at VADEQ monitoring station 2-JMS110.30. Low dissolved oxygen is considered a non-stressor (Figure 3.2).

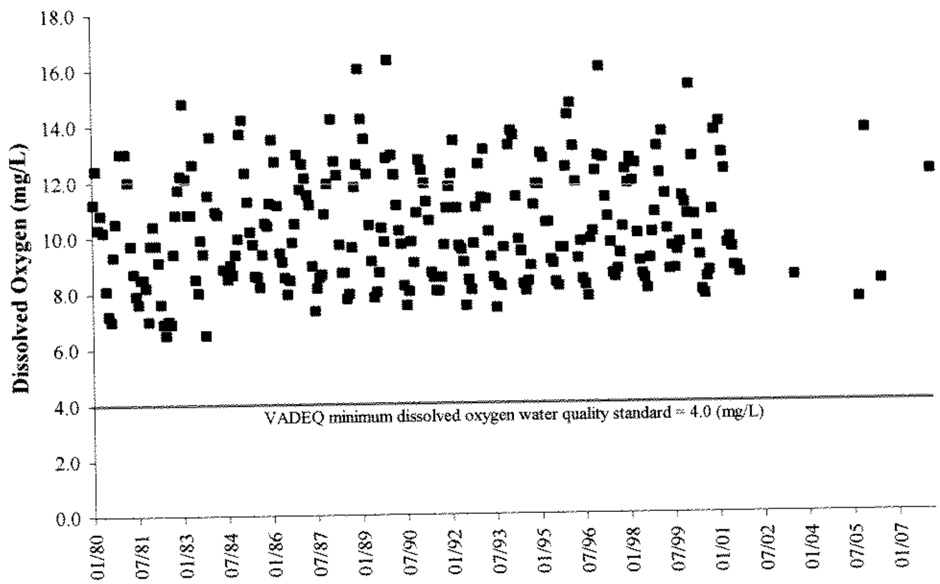

Figure 3.2 Dissolved oxygen concentrations at VADEQ monitoring station 2-JMS110.30.

3.1.2 Toxics (ammonia, PCBs, Pesticides, and PAHs)

The majority (80%) of the total ammonia (NH_3/NH_4) samples collected at the VADEQ monitoring station 2-JMS110.30 were below the minimum laboratory level of detection (0.04 mg/L). VADEQ stopped analyzing for total ammonia in 1995; and, as Figure 3.3 indicates, all total ammonia values were well below the chronic water quality standard (WQS). (Chronic and acute ammonia water quality standards vary, depending on the pH and temperature of the stream at the time of sample collection). VADEQ has consistently collected dissolved ammonia from 1984 until the present. There is no WQS for dissolved ammonia; however, 63% of the values collected were below the minimum laboratory level of detection (0.05 mg/L), and there has been a general downward trend in concentrations from 1984 to the present. Therefore, ammonia is considered a non-stressor in the James River at Richmond.

Sediment pesticides, PAHs, and PCBs were all below established screening levels (Chapter 2 section 2.4.1.1). Fish tissue sampling for PCBs and PAHs was not performed within the impaired segmen;t however, fish samples were collected at VADEQ monitoring station 2-JMS110.00, which is located below the fall line in the tidal influenced section of the James River. PCB concentrations exceeded the VADEQ screening value of 54 ppb and/or the VDH upper level of concern value of 500 ppb in 12 different species of fish collected in September 2001, March 2003 and April 2006. The PCB screening values are based on human health concerns, not toxicity to aquatic life. PCBs bioaccumulate in organisms tissues and concentrations increase further up the food chain. Ammonia, Pesticides, PCBs and PAHs (See Table 3.1) are considered non-stressors in the James River at Richmond.

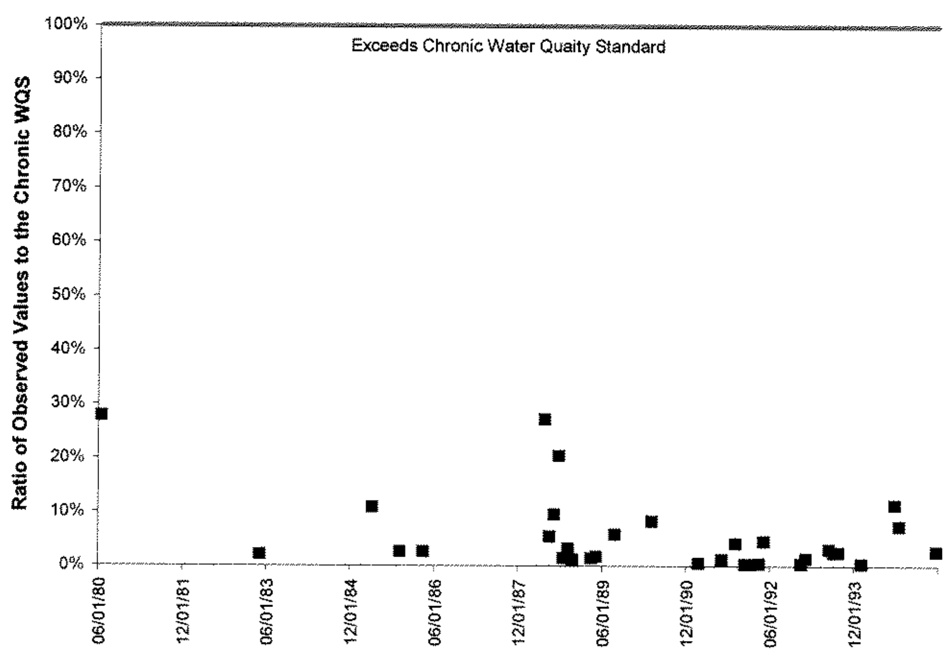

Figure 3.3 Ratio of observed total ammonia concentrations to the chronic WQS at VADEQ monitoring station 2-JMS110.30.

3.1.3 Metals

This section discusses VADEQ water quality monitoring for metals dissolved in the water column, metals in the sediment, and metals in fish tissue. All sediment metal values were below the PEC values (Chapter 2 section 2.4.1.1).

Water column dissolved metals were not sampled at monitoring stations within the impaired segment but concentrations at VADEQ monitoring station 2-JMS117.35 were below WQS. Not all of the metals listed have established VADEQ or USEPA water quality standards.

Fish tissue sampling for metals was not performed within the impaired segment; however, fish samples were collected at VADEQ monitoring station 2-JMS110.00, which is located below the fall line in the tidal influenced section of the James River. Largemouth Bass and Channel Catfish samples collected on 3/19/2003 had mercury concentrations in excess of the VDH level of concern (0.5 ppm). A Hickory Shad collected on 4/25/2003 had an arsenic concentration that exceeded the VADEQ screening value of 0.072 ppm. Follow-up sampling on 4/24/2006 found arsenic concentrations in Striped Bass, Blueback Herring and Hickory Shad that exceeded the VADEQ arsenic screening value. In addition, the VADEQ mercury screening value of 0.3 ppm was exceeded in Striped Bass and Blueback Herring. The metals screening values are based on human health concerns not toxicity to aquatic life. Metals bioaccumulate in organisms tissues and concentrations increase further up the food chain.

Based on the results of the dissolved and sediment metals concentrations, metals are considered non-stressors for the benthic impairment.

3.1.4 Temperature

The maximum temperature standard for the James River at Richmond, VA is 32.0°C. The maximum temperature recorded at the VADEQ monitoring station 2-JMS110.30 was 33°C in July 1983 (Figure 3.4). A temperature value also exceeded the maximum VADEQ WQS in August 1980 (32.5°C). There have been no additional WQS violations, and temperature is considered a non-stressor in James River at Richmond, VA.

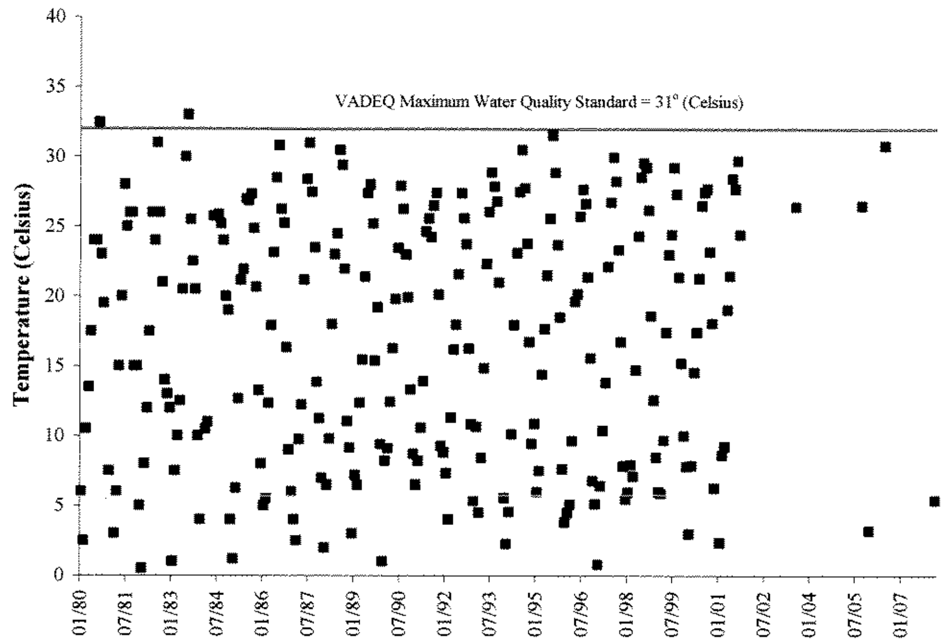

Figure 3.4 Temperature measurements at VADEQ station 2-JMS110.30.

3.1.5 Sediment

Total suspended solids concentrations at VADEQ monitoring station 2-JMS110.30 are similar to those at monitoring station 2-JMS117.35 (Figure 3.5). Maximum concentrations were higher at station 2-JMS110.30 which is probably due to runoff from the urban areas in the City of Richmond. The highest values were consistently recorded during periods of very high flows. The maximum value recorded at 2-JMS110.30 was 718 (mg/L) in April 1992 and 356 (mg/L) in March 2001 was highest value recorded at station 2-JMS117.35. The maximum value recorded at monitoring station 2-JMS110.30 in April 1992 was on day when the stream flow was well in excess of the 99th percentile (47,916 cfs). It is interesting to note the average, median, and 90th percentile, TSS concentrations are higher at the upstream VADEQ monitoring station (2-JMS117.35).

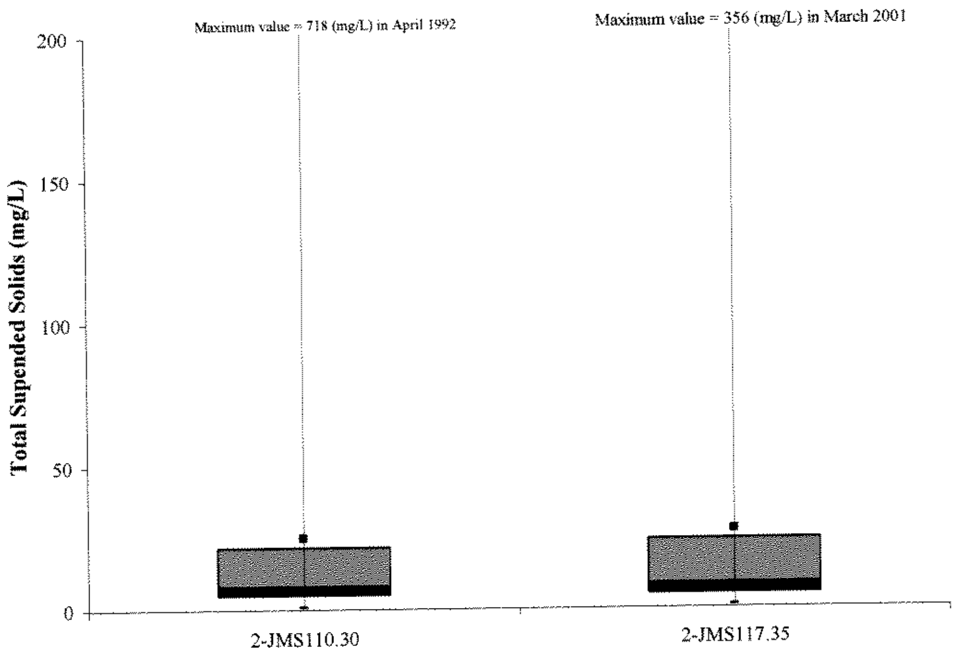

Figure 3.5 Total suspended solids comparison at VADEQ monitoring stations 2-JMS110.30 and 2-JMS117.35.

The two habitat parameters that indicate excessive sediment averaged in the optimal and sub-optimal categories at VADEQ benthic monitoring station 2-JMS110.34 (habitat data is discussed in Chapter 2 Section 2.3.1). Embeddedness is a measure of the amount of fine sediment that fills the spaces between the rocks in riffle areas. Excessive Embeddedness decreases the amount of habitat available for benthic macroinvertebrates. The average Embeddedness score since 2005 at monitoring station 2-JMS110.34 is 13, which is in the sub optimal category and considered good. In fact, the average Embeddedness score at station 2-JMS110.34 is slightly lower than the average at monitoring station 2-JMS110.44; and monitoring station 2-JMS110.44 has scored in the VASCI not-impaired category since the fall of 2005. In the spring of 2005, the Embeddedness score was in the marginal category at monitoring station 2-JMS110.34. Ironically, the Embeddedness score was in the marginal category during the fall of 2005 benthic survey at monitoring station 2-JMS110.44, but its VASCI score indicated there was no impairment.

Excessive sediment does not appear to be a persistent problem at the impaired benthic monitoring station, and is therefore considered a non-stressor.

3.1.6 Organic Matter

There are several parameters which can be used to evaluate excessive organic matter in a stream (total organic solids (TOS), total organic carbon (TOC) and total kjeldahl nitrogen (TKN). Excess organic matter can provide additional food sources for bacteria and the process of decomposition can lower dissolved oxygen concentrations, which can harm aquatic life. TOS concentrations at VADEQ monitoring station 2-JMS110.30 were very similar to those at monitoring station 2-JMS117.35 (Figure 3.6). A maximum value of 107 (mg/L) was recorded at monitoring station 2-JMS110.30 in April of 1992 when the stream flow was in excess of the 99^{th} percentile (47,916 cfs). However, average, median and 90^{th} percentile concentrations were higher at the upstream monitoring station, 2-JMS117.35.

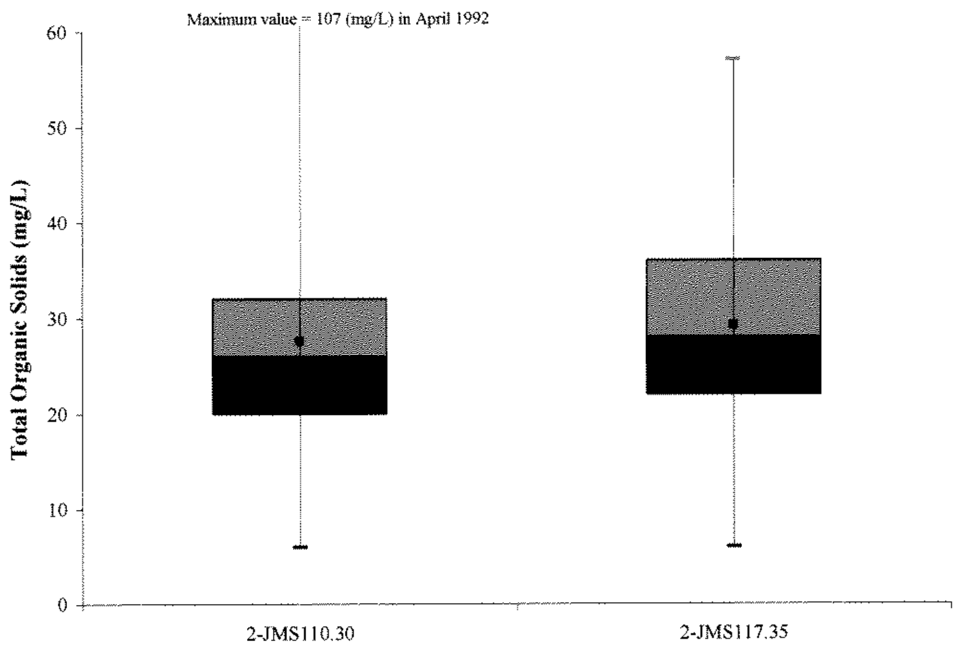

Figure 3.6 Total organic solids comparison at VADEQ monitoring stations 2-JMS110.30 and 2-JMS117.35.

TOC is a measure of the amount of carbon present in organic compounds and can be used as a non-specific indicator of excessive organic matter in a stream. TOC concentrations are generally higher at the upstream monitoring station 2-JMS117.35 (Figure 3.7).

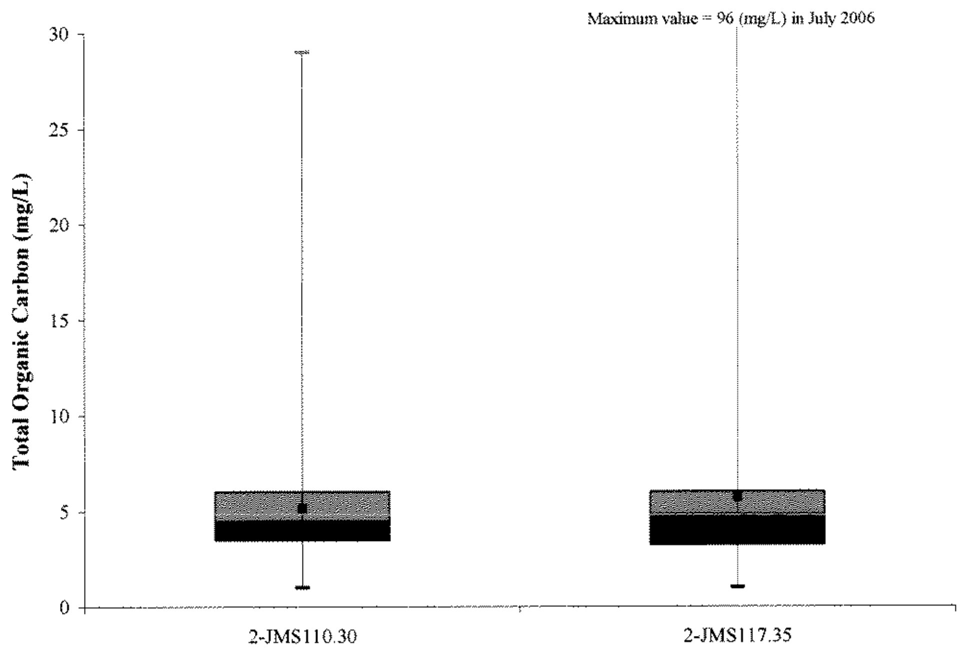

Figure 3.7 Total organic carbon comparison at VADEQ monitoring stations 2-JMS110.30 and 2-JMS117.35.

TKN is a measure of the amount of organic nitrogen. TKN concentrations were very similar between upstream and downstream VADEQ monitoring stations. In general, concentrations were slightly higher at the downstream monitoring station (Figure 3.8).

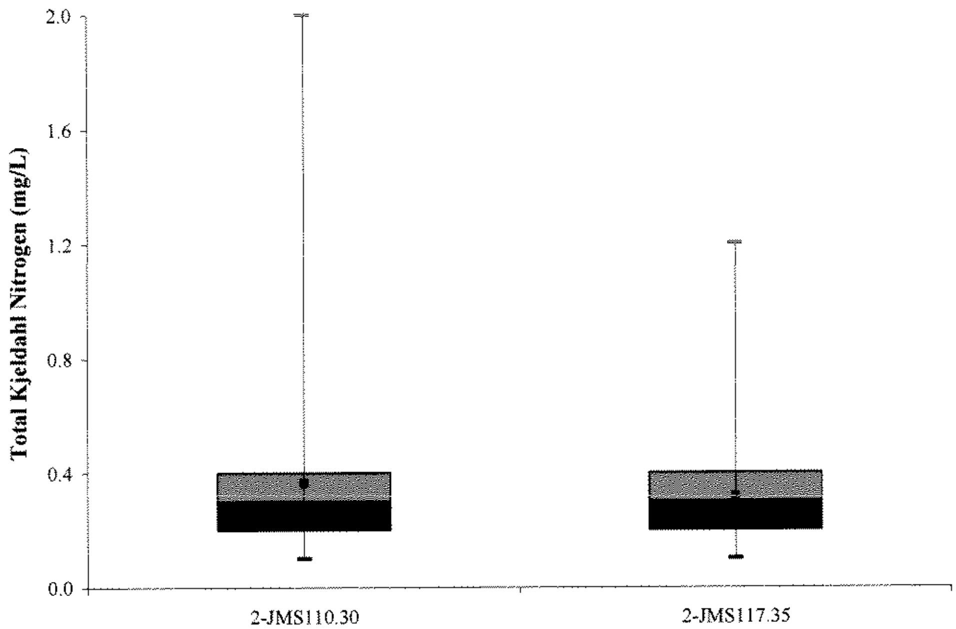

Figure 3.8 Total Kjeldahl Nitrogen comparison at VADEQ monitoring stations 2-JMS110.30 and 2-JMS117.35.

Organic matter in the impaired section of the river does not appear to be significantly different from the upstream sections of the river that are not impaired. Therefore, organic matter is considered a non-stressor in the James River at Richmond.

3.2 Possible Stressors

Table 3.2 Possible Stressors in the James River at Richmond, VA.

Parameter	Location in Document
Nutrients	Section 3.2.1
Field pH	Section 3.2.2

3.2.1 Nutrients

Total phosphorus (TP) concentrations are somewhat high at VADEQ ambient monitoring station 2-JMS110.30. Fifteen percent of the concentrations out of 22 samples exceeded the VADEQ screening value of 0.2 mg/L (Figure 3.9). However, TP concentrations at VADEQ monitoring station 2-JMS117.35, upstream of the non-impaired benthic monitoring station, are statistically similar to those at monitoring station 2-JMS110.30. For example the long term median concentrations are 0.1 mg/L at both stations and the 90th percentile concentration is higher upstream (0.3 versus 0.25) than downstream (Figure 3.10). In addition, all of the concentrations that exceeded the VADEQ screening value occurred during the 1980s and early 1990s. The recent data collected at the impaired benthic monitoring station (2-JMS110.34) indicated that one value had exceeded the screening value. A maximum value of 1.2 (mg/L) was recorded at monitoring station 2-JMS110.30 in April of 1992 when the stream flow was in excess of the 99th percentile (47,916 cfs).

Total nitrate-nitrogen (NO3-N) concentrations were generally low with all of the concentrations well below 1.0 mg/L (Figure 3.11). Figure 3.12 shows that NO3-N concentrations at VADEQ monitoring stations 2-JMS110.30 and 2-JMS117.35 are virtually identical. Excessive nutrients do not appear to be a problem in the impaired segment on the James River and are therefore considered possible stressors.

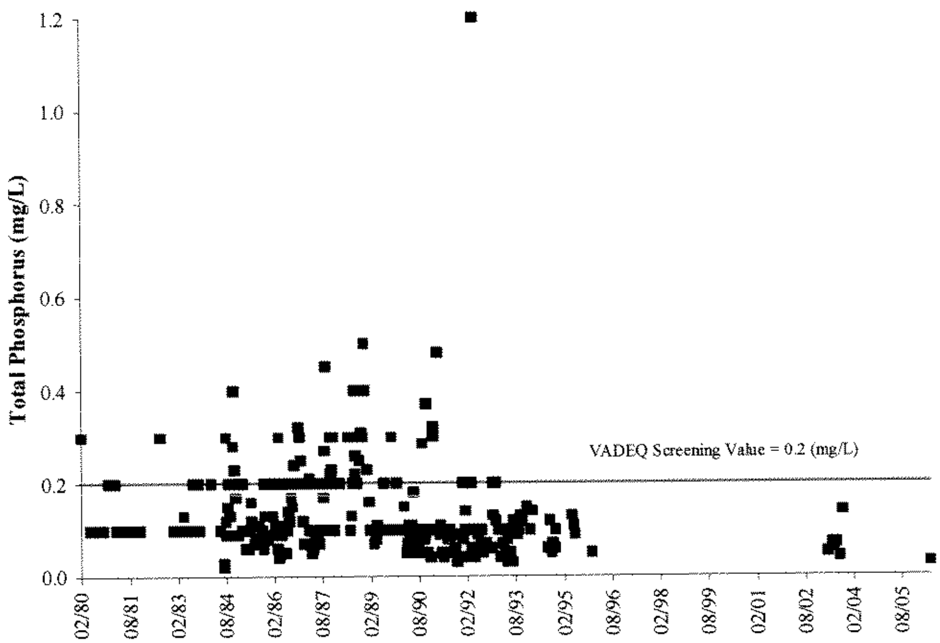

Figure 3.9 Total phosphorus concentrations at VADEQ station 2-JMS110.30.

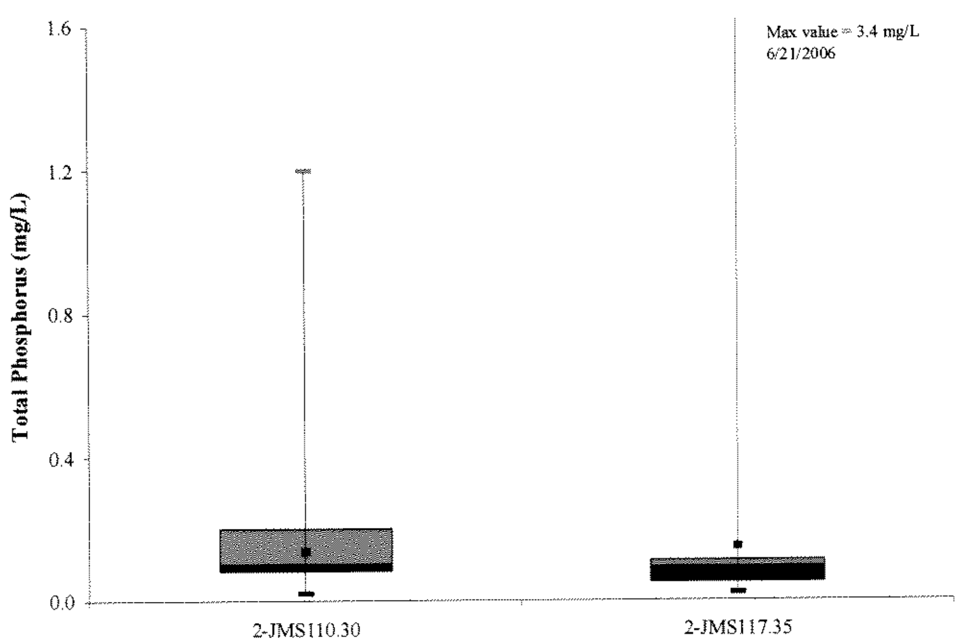

Figure 3.10 Total phosphorus concentration comparison at VADEQ stations 2-JMS110.30 and 2-JMS117.35.

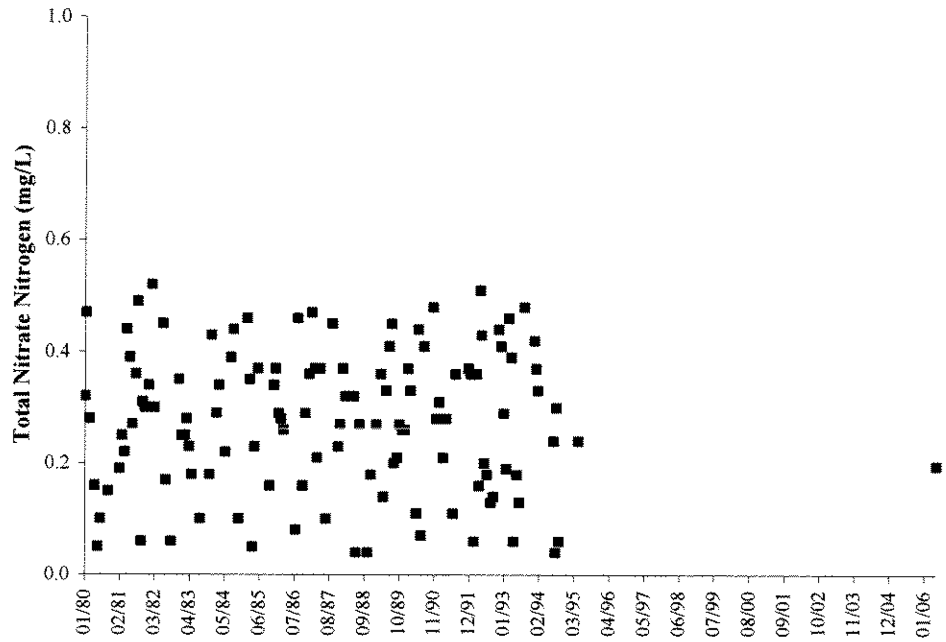

Figure 3.11 Nitrate-nitrogen concentrations at VADEQ station 2-JMS110.30.

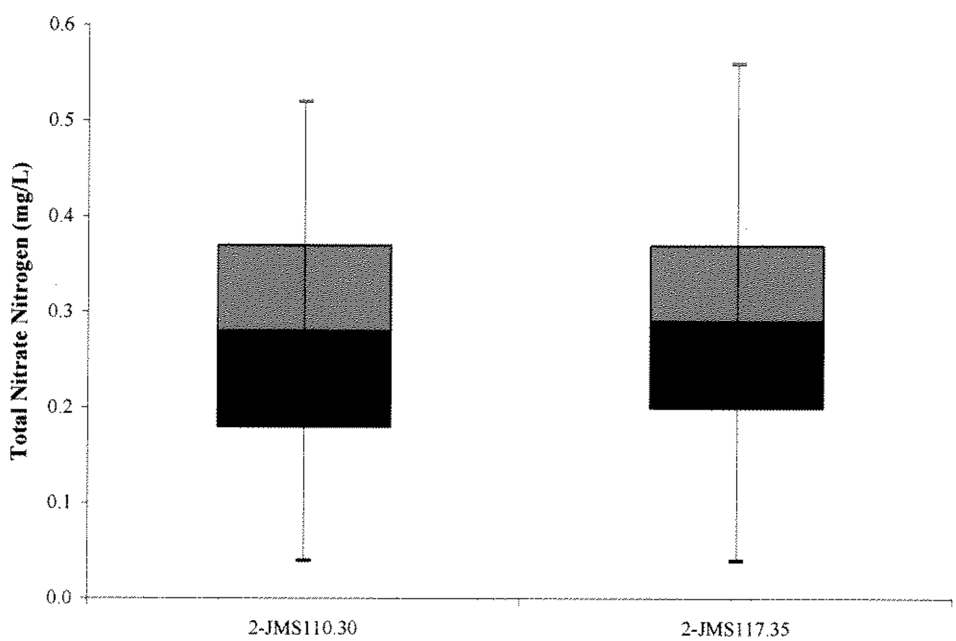

Figure 3.12 Total nitrate-nitrogen concentration comparison at VADEQ stations 2-JMS110.30 and 2-JMS117.35.

3.2.2 Field pH

Field pH values exceeded the maximum VADEQ maximum WQS (9.0 std units) five times out of 258 samples. The most recent exception occurred in May 1994. The maximum pH value measured was 9.3 std units in January 1983 at VADEQ monitoring station 2-JMS110.30 on the James River at Richmond, VA (Figure 3.13). Field pH WQS violations are not a chronic problem at this monitoring station and have not occurred since May of 1994. Therefore, field pH is considered a possible stressor in James River at Richmond, VA.

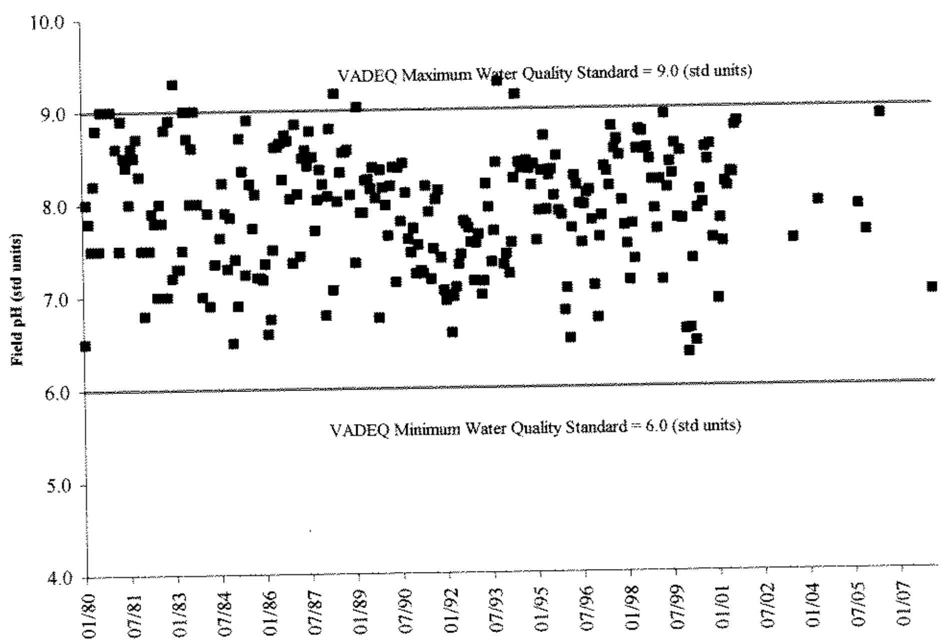

Figure 3.13 Field pH measurements at VADEQ station 2-JMS110.30.

3.3 Most Probable Stressor(s)

A most probable stressor was not determined from the available data. However, CSO number 040 (discussed in section 2.4.1.3) is located approximately 1,771 feet upstream from the impaired benthic monitoring station 2-JMS110.34, and could be potentially impacting the benthic community in ways that the current data do not indicate. A fecal bacteria TMDL for the same impaired segment of the James River is being developed for VADEQ by MapTech, Inc. and will be completed in early 2010. The fecal bacteria TMDL will address storm water loading reductions. In addition, MapTech, Inc. has been contracted to develop a TMDL implementation plan for the City of Richmond area that specifically addresses stormwater and related CSO best management practices (BMPs).

Because the most likely potential stressor to the benthic community is being addressed by an existing TMDL and implementation plan the impaired benthic segment on the James River that includes monitoring station 2-JMS110.34 will be listed as a category 4(a) water (segment is impaired but a TMDL has been developed) on the 2010 305(b)/303(d) Water Quality Assessment Integrated Report. VADEQ will continue to monitor at benthic and ambient monitoring station 2-JMS110.34.

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VADEQ. 2004. Section 303(d) Water Quality Assessment Integrated Report.

VADEQ. 2006. Section 303(d) Water Quality Assessment Integrated Report.

VADEQ. 2008. Section 303(d) Water Quality Assessment Integrated Report.

VADEQ and VADCR. 1998. Section 303(d) Total Maximum Daily Load Priority List and Report.

ATTACHMENT 3
Correspondence between EPA Biologist and VDEQ Biologist regarding James River Benthic Impairment Data

From: Pond.Greg@epamail.epa.gov
Sent: Sunday, August 16, 2009 12:20 PM
To: Pond.Greg@epamail.epa.gov
Cc: Passmore.Margaret@epamail.epa.gov; Smigo,Margaret; Alling,Mark; Smigo,Warren; Shanabruch,William
Subject: Re: FW: James River benthic TMDL/ comments appreciated

OK, so I had a chance to look at the data. I have a feeling that there might be patch-type specific effects with the sampled substratum on the southside, but would not rule out unknown toxic-type effects from urban tribs where flow hugs the southside (do you think your sample site is in a mixing zone of those tribs and the new diffuser?). I dont expect conductivity to be a stressor itself here, but is it different from northside? If elevated, could indicate other chemicals that could be problematic (you mentioned nutrients dont appear different). I noticed higher proportions of particular tolerant taxa on southside samples with opposing influences of rare taxa (1-2 individuals) on VSCI at the reference and northside samples (a problem with 100 count samples). Does wq or habitat limit those rarely collected taxa on the southside? Hard to tell.

Also, will Maptech do the stressor ID before any TMDL modeling, or has a stressor ID already been done? Can any RBP habitat metrics give any insight to site-specific problems affecting the sample? Does the winter- and spring-time flows scour your sampled substrate, or armour it? Maybe spring sampling is inappropriate for this section of the river? Have you ever sampled the urban tribs upstream of southside site? As I am unsure of the exact spatial nature of your sampling sites, would it be unwise to "average" VSCI scores between southside and northside to give an overall picture of benthic condition below Richmond? Sorry for the 101 questions !! Urban river stressors are complex as you pointed out below.

I do not see a smoking gun in the dataset. Reduced overall taxa richness at the southside might be an artifact of substrate patch dynamics compounded with low subsample size and family-level ID--or, real chemical stressors. How different are epifaunal substrate and embeddedness habitat metrics between southside and other sites? Are current velocities at north versus southside obviously different where you take samples?

Check individual VSCI metric scores between sites/seasons to see if any one or two metrics are driving down the southside samples.

I would be willing to review additional info if you'd like me to. Very interesting!

Greg

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From: Greg Pond/R3/USEPA/US
To: "Smigo,Warren" <Warren.Smigo@deq.virginia.gov>
Cc: "Smigo,Margaret" <Margaret.Smigo@deq.virginia.gov>, "Alling,Mark" <Mark.Alling@deq.virginia.gov>, "Shanabruch,William" <William.Shanabruch@deq.virginia.gov>, Margaret Passmore/R3/USEPA/US@EPA
Date: 08/10/2009 10:14 AM
Subject: Re: FW: James River benthic TMDL/ comments appreciated

---

Hey Warren et al., my apologies for not getting on this right away. I have been caught up in coal mining issues such that I have all but abandoned my other duties to non-coal folks such as yourselves. But because I love you all like kin-folk, I hope to get you some comments ASAP. Interesting background, and I hope to help figure this out with you if I havent passed up a deadline you

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Visit our website at http://epa.gov/reg3esd1/3ea50.htm

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To: "Smigo,Warren" <Warren.Smigo@deq.virginia.gov>
Cc: "Smigo,Margaret" <Margaret.Smigo@deq.virginia.gov>, "Alling,Mark" <Mark.Alling@deq.virginia.gov>, "Shanabruch,William" <William.Shanabruch@deq.virginia.gov>, Margaret Passmore/R3/USEPA/US@EPA
Date: 08/12/2009 10:14 AM
Subject: Re: FW: James River benthic TMDL / comments appreciated

---

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Best,

Greg

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From: "Smigo,Warren" <Warren.Smigo@deq.virginia.gov>
To: Greg Pond/R3/USEPA/US@EPA
Cc: "Shanabruch,William" <William.Shanabruch@deq.virginia.gov>, "Smigo,Margaret" <Margaret.Smigo@deq.virginia.gov>, "Alling,Mark" <Mark.Alling@deq.virginia.gov>
Date: 07/24/2009 01:20 PM
Subject: FW: James River benthic TMDL/ comments appreciated

Hey Greg,

Hope your summer is going well. We would love to have your comments on this (see below and attached spreadsheet) when you have time.

Thanks,

Warren Smigo

From: Smigo,Warren
Sent: Friday, April 17, 2009 1:28 PM
To: Cumbow,Eddy; Sparks,Lanny; Dail,Mary; Hazlegrove,Kelly; Shaver,Michael; Hill,Jason; Devlin III,George; Miller,Richard; Willis,Lawrence; Shanabruch,William; Brown, W. Gregory; Classen,Jeanne; VanWart,William; Turner,Robert; Silvia,Antone
Cc: Alling,Mark; Smigo,Margaret; Harris,Kelley; Palmore,Jennifer; 'Rod Bodkin'; Genung,Aimee
Subject: James River benthic TMDL/ comments appreciated

Hello everyone,

We have an interesting benthic TMDL situation and Mark Alling suggested that we get input from other regional biologists. (Actually, this is also a great case for the benthic TMDL workgroup to consider.) Please help!!

First, here is a little background. Our former regional biologist performed benthic sampling at 3 sites on the James River within the city of Richmond back in the 90's. The reference site (2-JMS115.29) was at the upstream end of the James River in Richmond and above any influence from the infamous Richmond CSO system. The other two stations were located downstream from most of the CSO gates and just upstream of tidal influence. One of the latter stations was located along the south bank (2-JMS110.34) and the other along the north bank a little further upstream (2-JMS110.44). Both of the downstream stations were listed as impaired due to poor benthic communities with a TMDL deadline of 2010. Knowing that this might be a controversial TMDL (since the city of Richmond has invested hundreds of millions of dollars over the last 10 – 20 years to reduce CSO overflow events), Mark asked us to start monitoring these stations back in 2004 and every year since.

During the last assessment cycle (data through 2006), the data led us to the rather bizarre conclusion that both the reference station (115.29) and the north bank station (110.44) were nonimmpaired. However, the south bank station (110.34) was still listed as impaired even though it is only 0.1 mile downstream of the north bank station. Now we have the 2007 and 2008 data to add to the mix. The good news is that the reference station and the north bank station are still scoring over 60 on the SCI. The interesting twist is that now the south bank station has improved to the point that it is giving mixed results with a fairly strong seasonal difference – Fall scores are better than Spring scores. So the question is what to do in light of the fact that MapTech was about to start serious work on the TMDL. Do we argue that the data for the south bank station is good enough to de-list or do we go through with a TMDL for the south bank station even though the nearby north bank station is no longer impaired?

We can think of a couple different scenarios to account for why the south bank station scores lower than the nearby north bank station, especially in the Spring. First, this station is located at the Fall Line and sampling can be a little treacherous. It is possible that we are not always getting to the best habitat during Spring sampling at the south bank station when the water level tends to be higher. Second, there are a couple different theories for how the south bank station could be subject to more water quality issues (nutrients, sediment, toxics) than the north bank station. These possibilities include a new CSO diffuser that would have a disproportionate influence on the south bank and also a couple urbanized tributaries entering the James from the south side which could have a differential impact on the north and south banks. On the other hand, we have been collecting nutrient samples monthly for the last couple years at these stations and do not see any obvious differences.

We have attached SCI scores and taxa lists for these 3 stations starting with the last data Richie collected in 1997. Please provide any thoughts, recommendations, etc. And of course, feel free to ask us any questions.

Thanks!

Bill and Warren

<<James River TMDL taxa info.xls>> [attachment "James River TMDL taxa info.xls" deleted by Greg Pond/R3/USEPA/US]